**AMSAT**

Radio Amateur Satellite Corporation
P.O. BOX 27, WASHINGTON, D.C. 20044

P.O. Box 177
Warwick, N.Y. 10990
18 Jul 85

MEMORANDUM

To: Distribution
From: V.Rip
Subject: NASA Notice of Inquiry For ACTS Experimenters

1. The Advanced Communications Technology Satellite will be launched by NASA in 1989. As the program name suggests, the ACTS will advance the state of the art.

2. A recent NASA Notice of Inquiry (NOI) leaves open the possibility that a suitablly accoutred group of professional Amateurs (Amateur professionals?) could acquire free use for two years of a geo-stationary transponder to perform interesting experiments as part of the overall ACTS experimental regime.

3. There is a likelihood AMSAT can design a series of experiments and develop/acquire the required experimental apparatus (earth station, switching and telecommunications equipment) to have a run at the objective. ARRL may choose to team with AMSAT in a proposal to NASA or we may chose different courses.

4. In any case, there is sufficient appeal in the program to engage a preliminary study into what MIGHT be achieved if we invest talent and time in a serious proposal effort.

5. The technical challenges are substantial; many believe unattainable by all but the top industrial/academic/military groups. While I'll concede the challenge is great, we do have the collective ability to achieve an experimental berth on ACTS.

6. The preliminary documents are attached. Please read them at your convenience. I would like to be in a position to recommend to the Board a course of action in this regard by, say, the end of October. If a positive action (proposal effort) is to follow, I would target first quarter 1986 as a target.

7. Until a proposal and/or program manager is named, I will act as coordinator for the effort. Please discuss your thoughts and advise us when appropriate.

73,

Rip, WA2LQQ

attch: Dist list
NASA Docs pkg #1

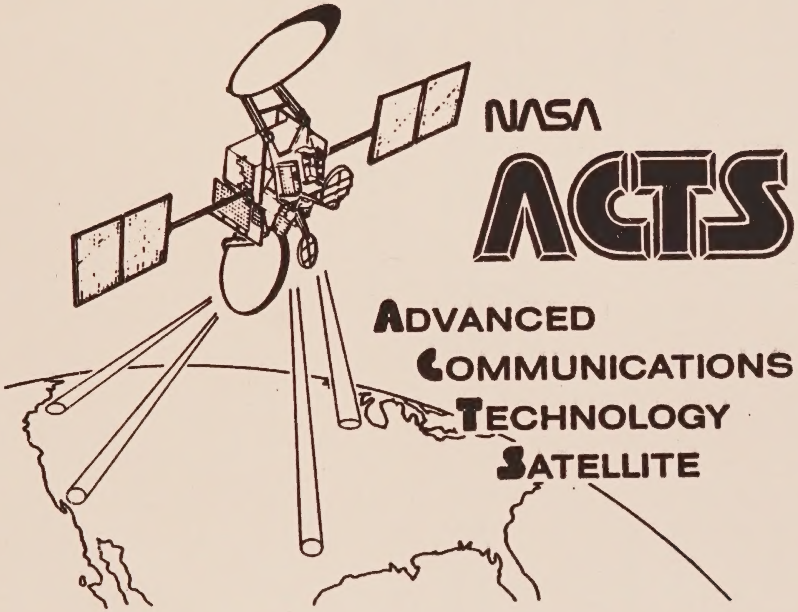
Attachment 1

Distribution List

Mr. Jan King, W3GEY and Mr. Gordon Hardman, KE3D/ZS6FE
7328 Island Circle, Boulder, CO 80301
Dr. Tom Clark, W3IWI
6388 Guilford, Clarksville, MD 20129
Mr. John Browning, W6SP
6202 Lochvale Drive, Rancho Palos Verdes, CA 90274
Dr. Al Dayton, KA4JFO
10221 Raider Lane, Fairfax, VA 22030
Dr. Perry Klein, W3PK
700 7th Street,SW, Washington, D.C. 20024
Dr Cleyon Yowell, AD6P
17912 Morrow Circle, Villa Park, CA 92667
Dr. Bill McCaa, K0RZ
P.O. Box 3214, Boulder, CO 80607
Mr. Gerry Marchal, WA8RYD
270 West Sharon Road, Cincinnati, OH 45246
Mr. Paul Rinaldo, W4RI
ARRL, 225 Main Street, Newington, CT 06111
Dr. Hank Magnuski, KA6M
311 Stanford Avenue, Menlo Park, CA 94025
Mr. Phil Karn, KA9Q
25B Hillcrest, Warren Township, N.J. 07060
Dr. John Champa, K8OCL
7800 Hartwell Street, Dearborn, MI 48126
Mr. Eugene Niemiec, K2KJI
66 Skytop Road, Cedar Grove, N.J. 07009
Dr. Karl Meinzer, DJ4ZC
An dem Brunnen Rohnen,21, Marburg, Hessen F.R. Germany
Dr. Martin Sweeting, G3YJO
Dept. of E.E., University of Surrey, Guildford, England GU2 5XH
Mr. Han Vande Groenendaal, ZS6AKV
P.O. Box 13273, Northmead 1511. South Africa
Mr. Dick Jansson, WD4FAB
1130 Willowbrook Trail, Maitland, FL 32751
Mr. Dick Daniels, W4PUJ
3120 North Thomas Street, Arlington, VA 22207
Mr. John Swancara, WA6LOD
1002 E. Mariposa Avenue, El Sugunda, CA 90245
Mr. Harold Price, NK6K
1211 Ford Avenue, Redondo Beach, CA 90278

# NASA-INDUSTRY-PARTNERSHIP

## EXPERIMENTS MEETING




MARCH 26, 1985

CRYSTAL CITY, VIRGINIA

# ACTS EXPERIMENTS MEETING

MARCH 26, 1985

HYATT REGENCY, CRYSTAL CITY

REGENCY C

AGENDA

| | | | |
|---|---|---|---|
| - | Registration | | 9:00 am |
| - | Welcome | Brandel | 9:30 |
| - | Introductory Remarks | Lovell | 9:45 |
| A | Program Goals | Brandel | 10:00 |
| B | ACTS Project | Gedney | 10:15 |
| C | Uses of ACTS Technology | Schertler | 10:30 |
| - | Break | | 10:45 |
| D | ACTS Communications System | Wright | 11:00 |
| - | Lunch | | 12:00 pm |
| E | Ground Terminals | Knight | 1:00 |
| F | Experiments Program | Schertler | 1:30 |
| - | Break | | 2:00 |
| G | Separate Group Discussion on Experiments | | 2:15 |
| | * 1. Technology (Flight, Ground, Network Control) | Wright | |
| | * 2. Propagation (Impairments, Enhancement) | Manning | |
| | ** 3. System and Applications Experiments | Brandel | |
| H | Comments by the Associate Administrator for Space Science and Applications | Edelson | 3:30 |
| I | Summary Remarks | Brandel | 3:45 |
| - | Adjournment | | 4:00 |

* Regency D

** Regency C

WP5011C

3-20-85

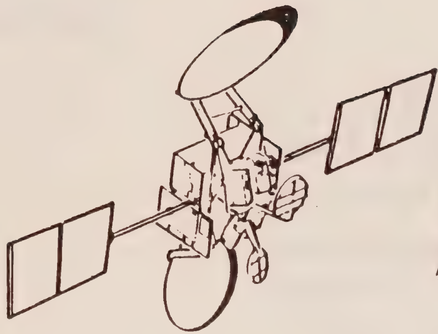
ACTS EXPERIMENTS MEETING - March 26, 1985

Registered Attendees as of 3-21-85



| | |
|---|---|
| AT & T Bell Laboratories | Bill Benden |
| AT & T Bell Laboratories | Robert J. Brown |
| Alternative Systems Laboratory | Alfred Pietrzyk |
| American Medical Assoc. | Carlos Martini, MD |
| American Satellite Co. | Michael R. Helton |
| American Satellite Co. | Shaum Mittal |
| ANALEX | Patrick L. Donoughe |
| ANALEX | Michael Kerpchar |
| ANALEX | Robert Manning |
| Annenberg/CPB Project | Dr. Peter J. Dirr |
| Arizona State University | Lee C. Frischknecht |
| Bendix Field Engineering | William Pfeiffer |
| Boeing Aerospace Company | Dean Gahagan |
| Boeing Aerospace Company | David Wax |
| Booz-Allen & Hamilton | Marc A. Polster |
| COMSAT General Corp. | Dr. Elizabeth Young |
| COMSAT General Corp. | Carrie Devieux, Jr. |
| COMSAT Laboratories | Dr. S. J. Campanella |
| COMSAT Laboratories | Larry Palmer |
| COMSAT Laboratories | Irving Dostis |
| Colorado Video, Inc. | Glen Southworth |
| Creighton University | Frederick Brigham |
| Department of Commerce - Inst. Tele. Science | Ray Jennings |
| Department of Commerce - Inst. Tele. Science | Bill Kissick |
| Department of Defense | Col. John Graves |
| Department of Defense | Major William Langford |
| Department of Defense | Richard Buehler |
| Department of Defense | John Woodell |
| Federal Communications Commission | Bruno Pattan |
| GTE - Government Systems | Hans J. Tiller |
| GTE - Spacenet | David F. Piske |
| GTE - Spacenet | Sid Skjei |
| GTE Laboratories, Inc. | E. P. Tweedy |
| GTE Sylvania | Henning Olesen |
| General Services Admin. | Gregory Bain |
| General Services Admin. | Robert Shephard |
| General Services Admin. | Robert J. Hofferty |
| General Telephone and Electronics | David Peske |
| Harris Corporation | Michael DeZego |
| Harris Corporation | Bill Whitehead |
| IBM Federal Systems Division | Ralph J. Metz |
| JPL | Ernest K. Smith |
| Johns Hopkins University | Dr. Julius Goldhirsh |
| LNR Communications, Inc. | Julius Asmus |
| LNR Communications, Inc. | John Edwards |
| Library of Congress | Dr. Joseph Price |
| Library of Congress | Robert Carneal |
| M/A - COM Research Center | Leonard S. Golding |
| M/A - COM Telecom. Div. | Jay Hustead |
| MITRE Corporation | Joe Fernandez |
| MITRE Corporation | Richard Smith |
| Maryland Public Television | Sidney Tishler |
| Motorola Inc., Govt Elec. Group | Ron Thomas |
| Motorola Inc., Govt Elec. Group | A. Boyd Holmes |

| | |
|---|---|
| N and F Associates | Frederick H. Brigham, Jr. |
| NASA Goddard Space Flight Center | S.H. Durrian |
| NASA Goddard Space Flight Center | Robert Fitzgerald |
| NASA Headquarters | Dr. Burt Edelson |
| NASA Headquarters | Daniel L. Brandel |
| NASA Headquarters | William T. Kondik |
| NASA Headquarters | Robert R. Lovell |
| NASA Lewis Research Center | Dr. Richard T. Gedney |
| NASA Lewis Research Center | John G. Bluck |
| NASA Lewis Research Center | William H. Hawersaat |
| NASA Lewis Research Center | Rodney M. Knight |
| NASA Lewis Research Center | Mary Ann Peto |
| NASA Lewis Research Center | Ronald J. Schertler |
| NASA Lewis Research Center | David L. Wright |
| NASA Lewis Research Center | Bruce Lindow |
| NASA Lewis Research Center | Brian May |
| NASA Lewis Research Center | Dale Pope |
| NASA Marshall Space Flight Center | Dr. James Green |
| National Communications System | Kenneth B. Boheim |
| National Communications System | Al Bartko |
| National Fire Protection Assn | James Smalley |
| New York Institute of Technology | Sir John Maniello |
| Public Serv. Satellite Consortium | Deb Gilman |
| Public Serv. Satellite Consortium | Karen Hutcheson |
| Public Serv. Satellite Consortium | Kim McDaniel |
| Public Serv. Satellite Consortium | Louis A. Bransford |
| Public Serv. Satellite Consortium | Mary D. Clark |
| RCA - Americom | Sandra Erb |
| RCA Astro-Electronic | Christopher White |
| Spacecom | Dr. Louis J. Ippolito |
| Spacecom | Paul Flikkema |
| Spacecom | Thomas van der Heyden |
| Satellite Business Systems | Donald Hill |
| Satellite Business System | Frank Stein |
| Satellite Business Systems | Dr. Duncan Mackinnon |
| Satellite Business Systems | Leonard Pugliese |
| Satellite Systems Engineering | Michael Herzfeld |
| Scientific Atlanta, Inc. | Ray Eckman |
| Scientific Atlanta, Inc. | Glenn Horning |
| Scientific Atlanta, Inc. | Bob Strickland |
| Scientific Atlanta, Inc. | B. L. Sullins |
| Southern Illinois University | Dr. K. S. Sitaram |
| TRW Inc. | Harold Braham |
| TRW Inc. | David Vridrine |
| U.S. Dept. of Transportation | Dr. Carl C. Clark |
| United States Secret Service | Tom Wiesner |
| University of Chicago | Dr. Don York |
| University of Chicago | Bob Lowenstein |
| University of Miami | Dr. H. W. Hiser |
| Virginia Polytechnic Inst. & State Univ. | W.L. Stutzman |
| Virginia Polytechnic Inst. & State Univ. | R. C. Robertson |
| Virginia Polytechnic Inst. & State Univ. | Dr. Charles Bostian |
| Voluntary Hospitals of America | J. Bruce Brennan |
| Western Michigan University | Charles Woodliff |
| Western Union Telegraph Co. | Wallace P. Mack |
| Western Union Telegraph Co. | John J. Spirito |



NASA

# ACTS

# ADVANCED COMMUNICATIONS TECHNOLOGY SATELLITE

## PROGRAM GOALS

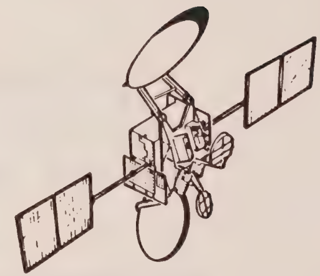
NASA
C-84-7174

NASA

ACTS ADVANCED COMMUNICATIONS TECHNOLOGY SATELLITE

## NASA HEADQUARTERS

- OFFICE OF SPACE SCIENCE AND APPLICATIONS
  Dr. Burton I. Edelson
- DIRECTOR OF COMMUNICATIONS DIVISION
  Robert R. Lovell

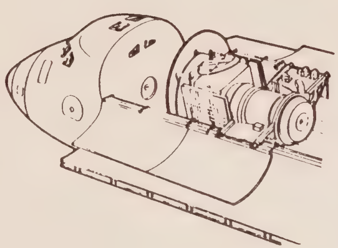


ACTS PROGRAM MANAGER
Dr. Daniel L. Brandel

DEPUTY PROGRAM MANAGER
William T. Kondik

## NASA LEWIS RESEARCH CENTER

- SPACE FLIGHT SYSTEMS DIRECTORATE
  Lawrence J. Ross



ACTS PROJECT OFFICE

PROJECT MANAGER
Dr. Richard T. Gedney, Acting

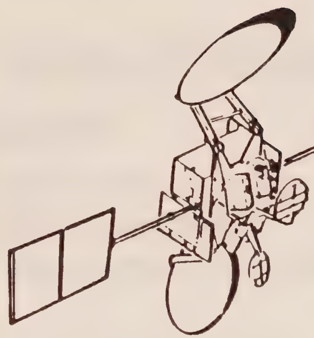
DEPUTY PROJECT MANAGER
William H. Hawersaat

PROJECT EXPERIMENTS MANAGER
Ronald J. Schertler

5

# ACTS PROGRAM OBJECTIVES

- DEVELOP THE PROOF OF CONCEPT TECHNOLOGY INNOVATION NEEDED TO ACHIEVE FREQUENCY REUSE AND INCREASED SATELLITE CAPACITY FOR THE MID-1990's
- PROVIDE A FLIGHT TEST TO PROVE THE FEASIBILITY OF THIS TECHNOLOGY
- OBTAIN THE WIDEST POSSIBLE U.S. INVOLVEMENT OF INSTITUTIONS AND THE USER COMMUNITY IN THE EVALUATION AND TESTING OF THE TECHNOLOGY



NASA

ACTS

# ADVANCED COMMUNICATIONS TECHNOLOGY SATELLITE

## ACTS PROJECT

NASA

ACTS ADVANCED COMMUNICATIONS TECHNOLOGY SATELLITE

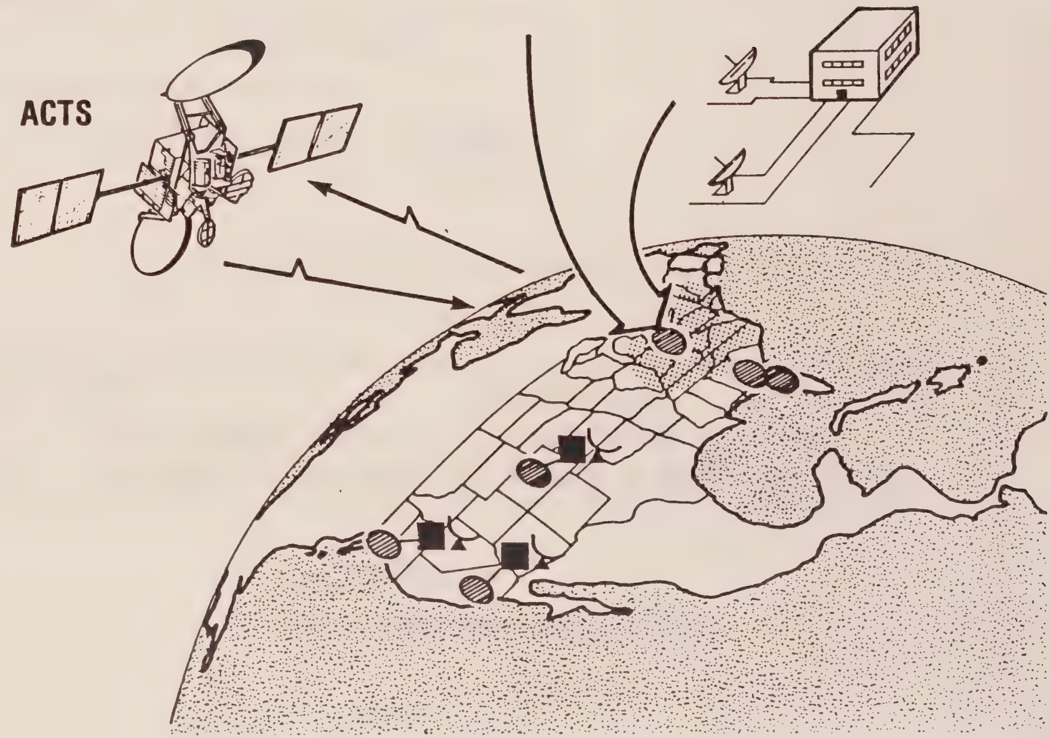
# ADVANCED COMMUNICATIONS TECHNOLOGY SATELLITE PROJECT

## OBJECTIVE

DEVELOP AND VERIFY THE ADVANCED MULTIBEAM COMMUNICATIONS TECHNOLOGY

## NASA LEWIS RESEARCH CENTER

- GROUND STATION WITH MASTER CONTROL




## EXPERIMENTERS

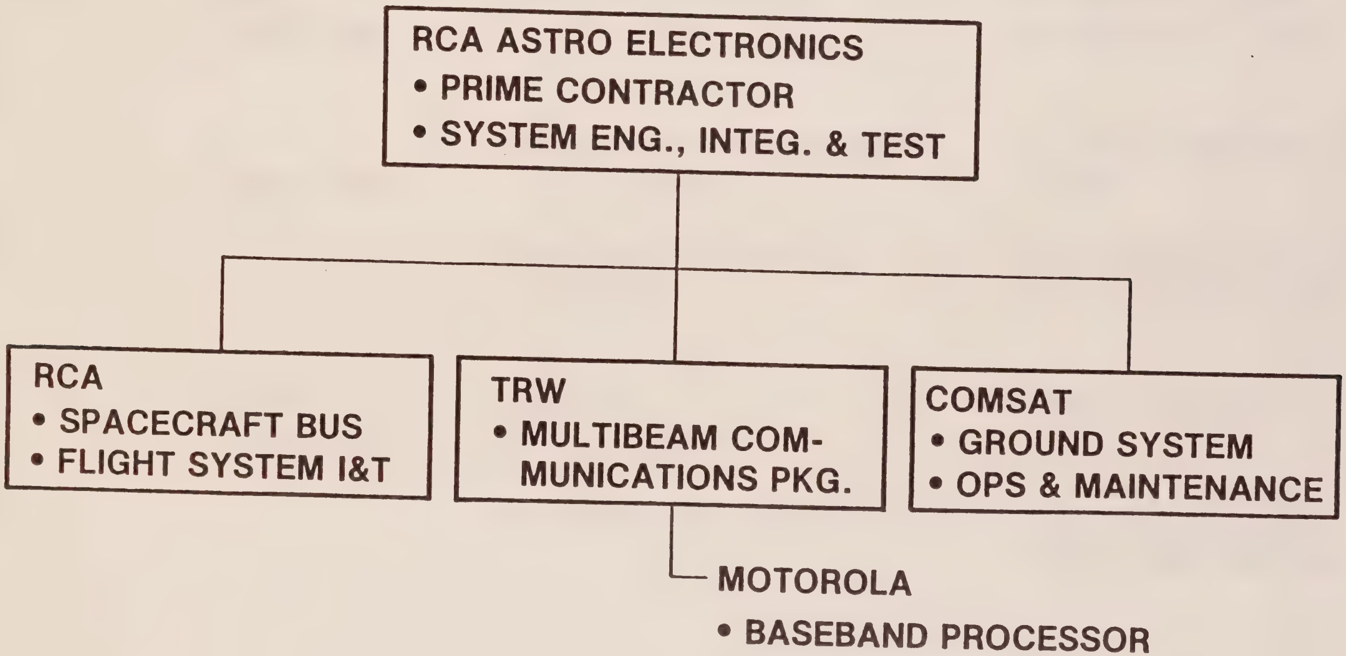
- NASA
- INDUSTRY
- UNIVERSITIES
- OTHER GOVERNMENT AGENCIES

8

NASA

ACTS ADVANCED COMMUNICATIONS TECHNOLOGY SATELLITE

# ACTS CONTRACTOR TEAM




9

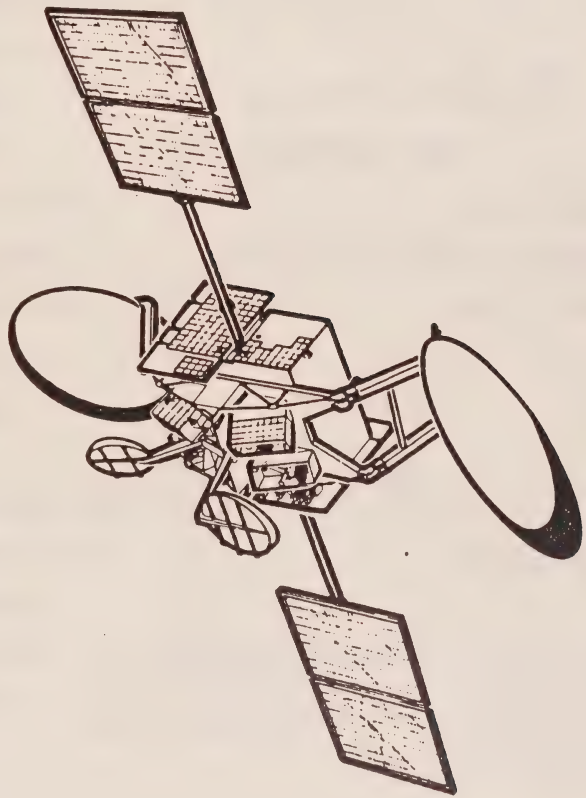
# ACTS CONTRACTOR TEAM

| | | |
|---|---|---|
| PRIME CONTRACTOR | RCA ASTRO ELECTRONICS<br>R. S. LAWTON | BUS AND ACTS SYSTEM INTEGRATION AND TEST |
| SUB-CONTRACTORS | TRW-ELECTRONIC SYSTEMS GROUP<br>T. J. JOHNSON | MULTIBEAM COMMUNICATION PACKAGE |
| | COMSAT-WORLD SYSTEMS DIV.<br>I. DOSTIS | NASA GROUND STATION AND MASTER CONTROL STATION |
| SUPPORT CONTRACTORS | MOTOROLA | BASEBAND PROCESSOR |
| | ELECTROMAGNETIC SCIENCES | BEAM FORMING NETWORK FOR MULTIBEAM ANTENNA |

NASA

ACTS ADVANCED COMMUNICATIONS TECHNOLOGY SATELLITE

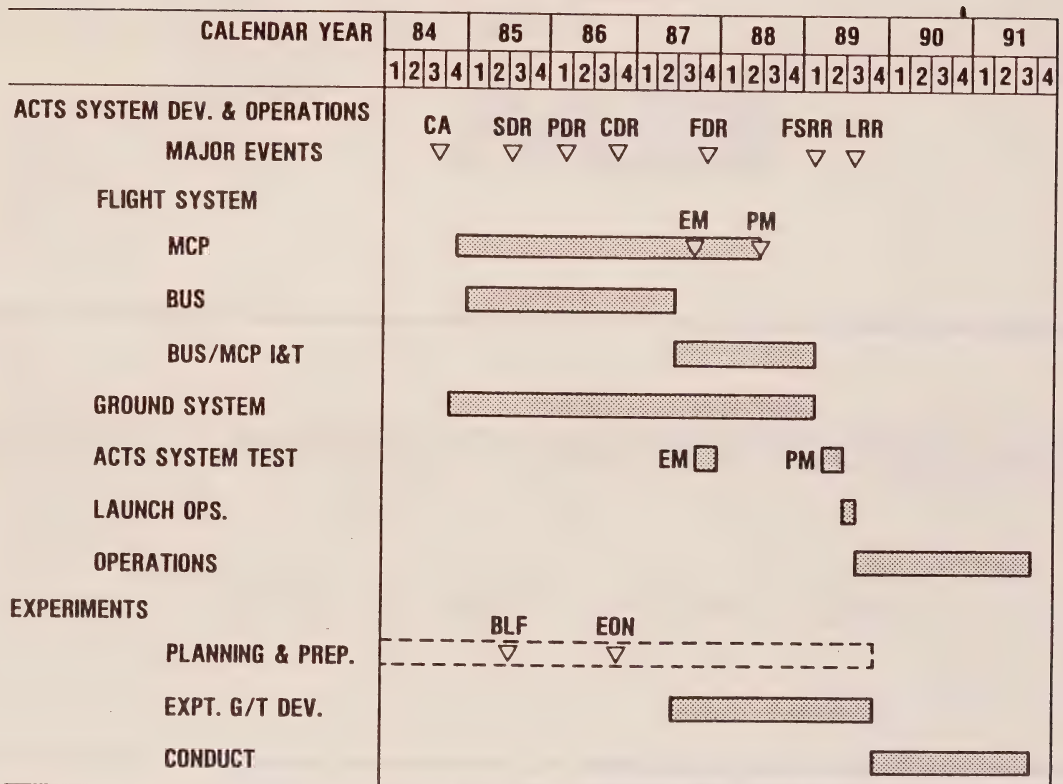
# ACTS IN GEOSYNCHRONOUS ORBIT



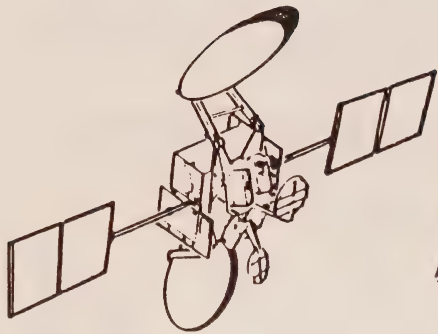
NASA

ACTS ADVANCED COMMUNICATIONS TECHNOLOGY SATELLITE

# ACTS PROJECT SCHEDULE




BLF BEAM LOCATIONS FINALIZED
CA CONTRACT AWARD
CDR CRITICAL DESIGN REVIEW
EM ENG. MODEL
EON EXPERIMENT OPPORTUNITY NOTICE
FDR FINAL DESIGN REVIEW
FSRR FLIGHT SYSTEM READINESS REVIEW
I&T INTEGRATION & TEST
LRR LAUNCH READINESS REVIEW
MCP MULTIBEAM COMMUNICATIONS PACKAGE
PDR PRELIMINARY DESIGN REVIEW
PM PROTOFLIGHT MODEL
SDR SYSTEM DESIGN REVIEW

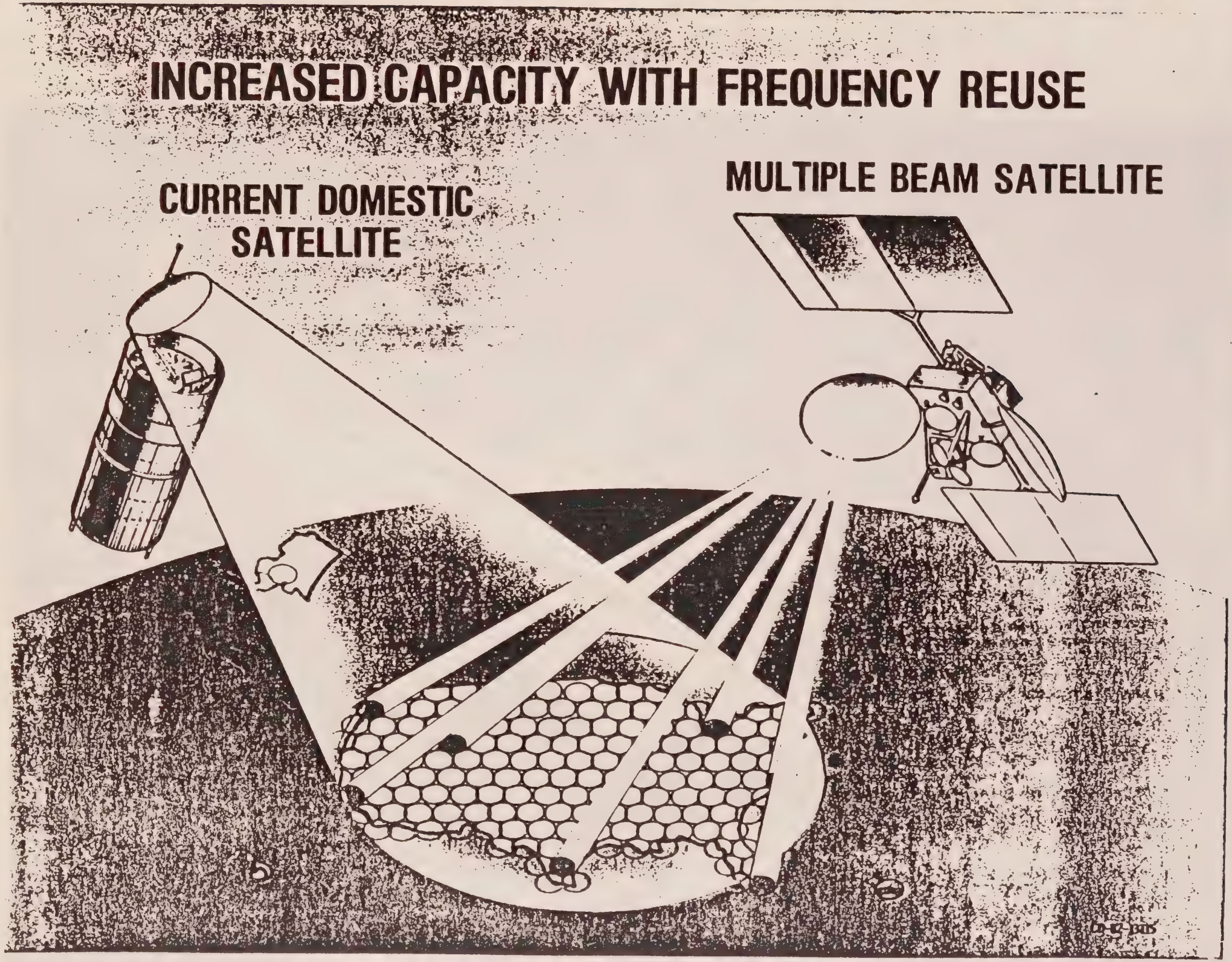


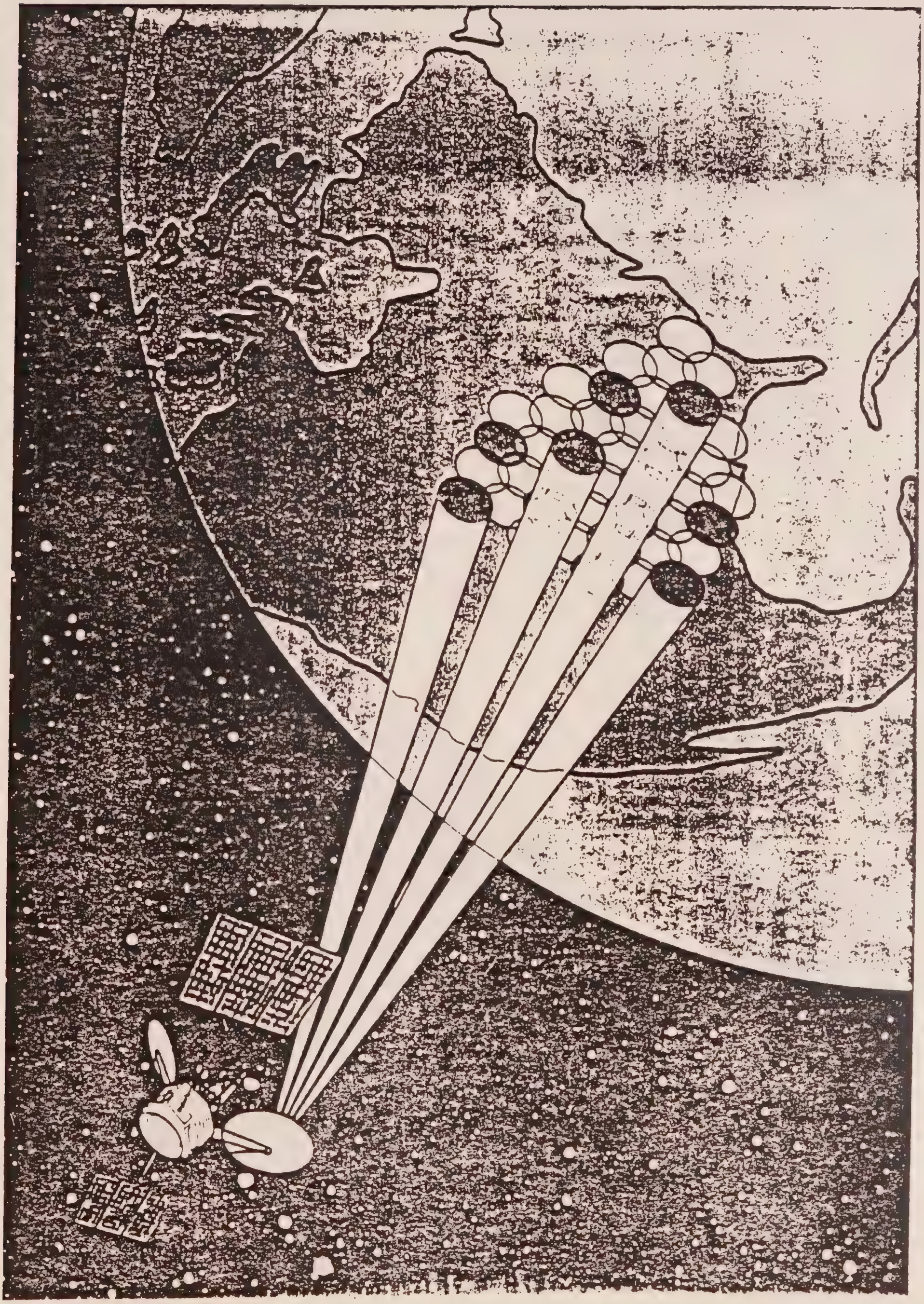
NASA

ACTS

# ADVANCED COMMUNICATIONS TECHNOLOGY SATELLITE

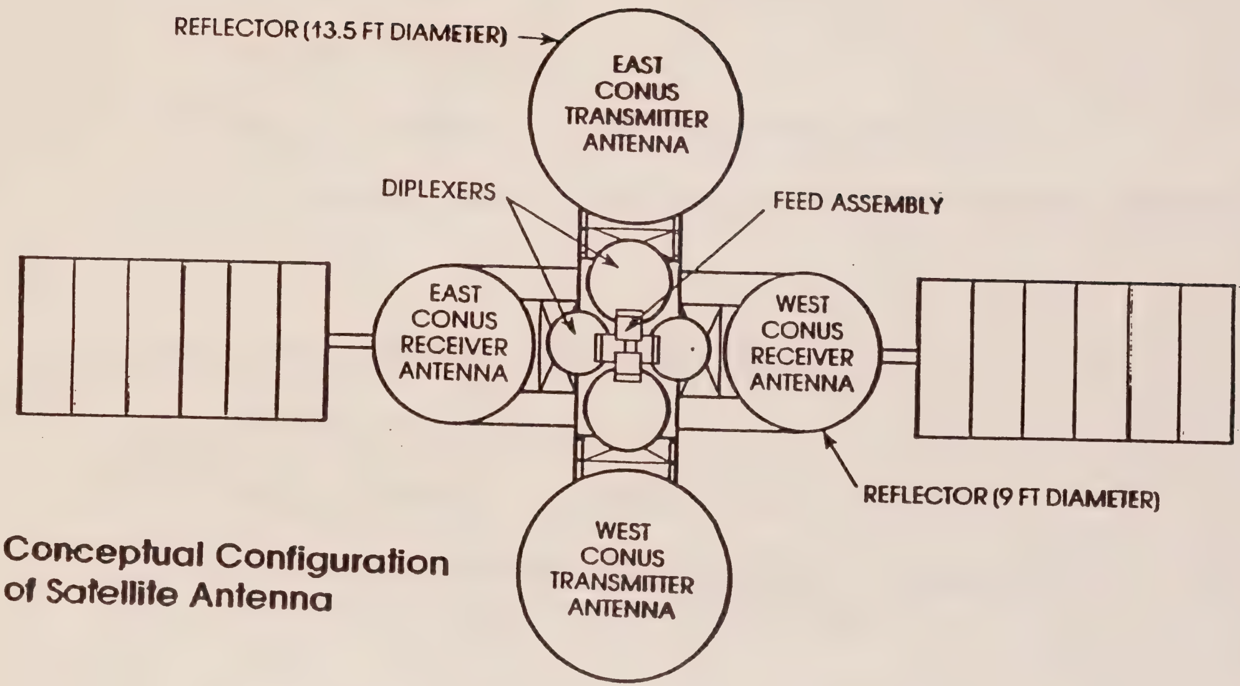
## USES OF ACTS TECHNOLOGY


INCREASED CAPACITY WITH FREQUENCY REUSE
CURRENT DOMESTIC SATELLITE
MULTIPLE BEAM SATELLITE



NASA
C-84-0666

NASA
C-84-0665




**Conceptual Configuration of Satellite Antenna**

## TYPICAL OPERATIONAL MULTIBEAM SATELLITE COMMUNICATIONS FOR KA BAND

### TRUNKING APPLICATION

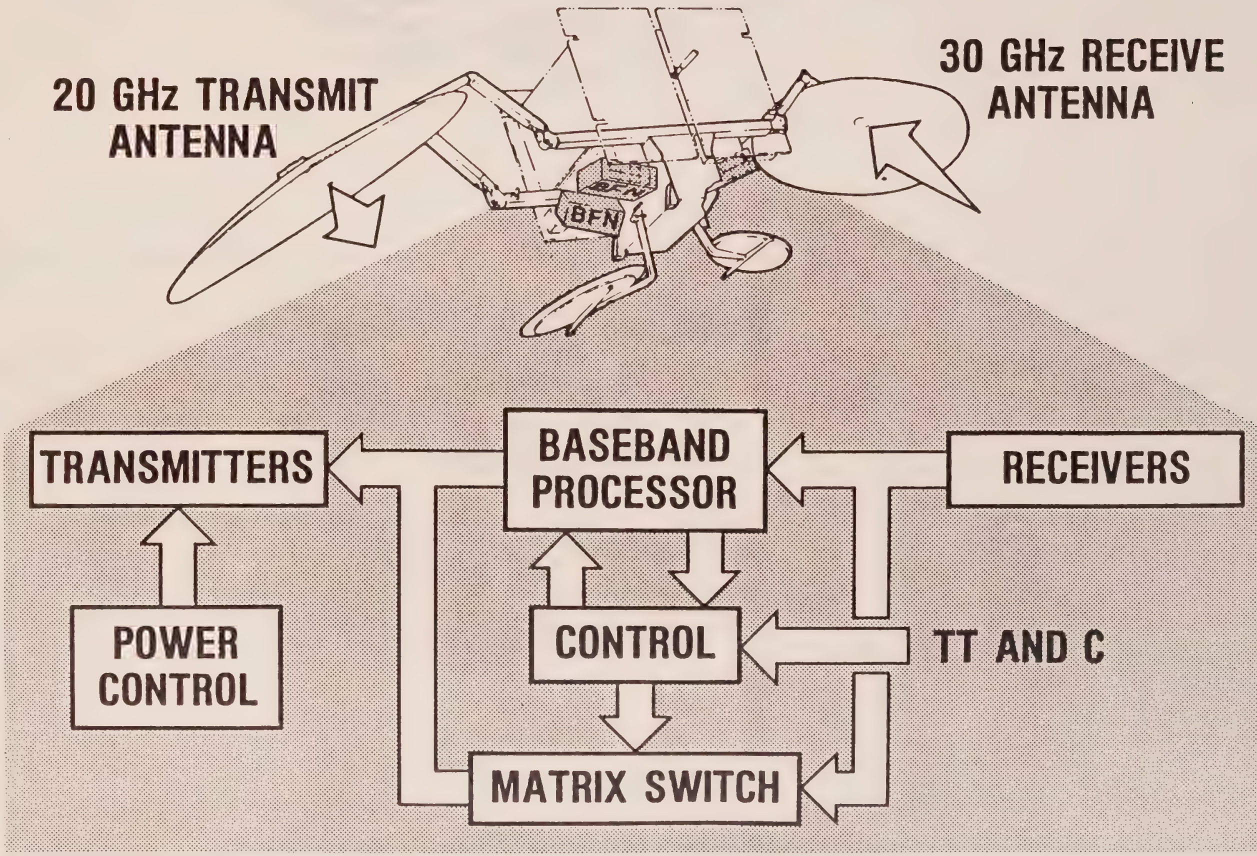
- o AVAILABILITY = 99.99%
- o SATELLITE CAPACITY 9 GBPS OR 140,000 VOICE CALLS
  - TRANSMIT BLOCKS OF MESSAGES BETWEEN CITIES EACH WITH A DIVERSITY SITE

### CUSTOMER PREMISES SERVICES (CPS) APPLICATION

- o AVAILABILITY = 99.5%
- o SATELLITE CAPACITY 4 GBPS OR 60,000 VOICE CALLS
  - TRANSMIT INDIVIDUAL MESSAGES BETWEEN THOUSANDS OF TERMINALS LOCATED ON CUSTOMER PREMISES

ACTS ADVANCED COMMUNICATIONS TECHNOLOGY SATELLITE

# MULTIBEAM COMMUNICATIONS PACKAGE

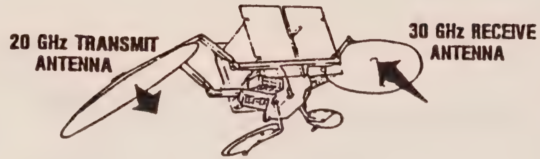



19

NASA

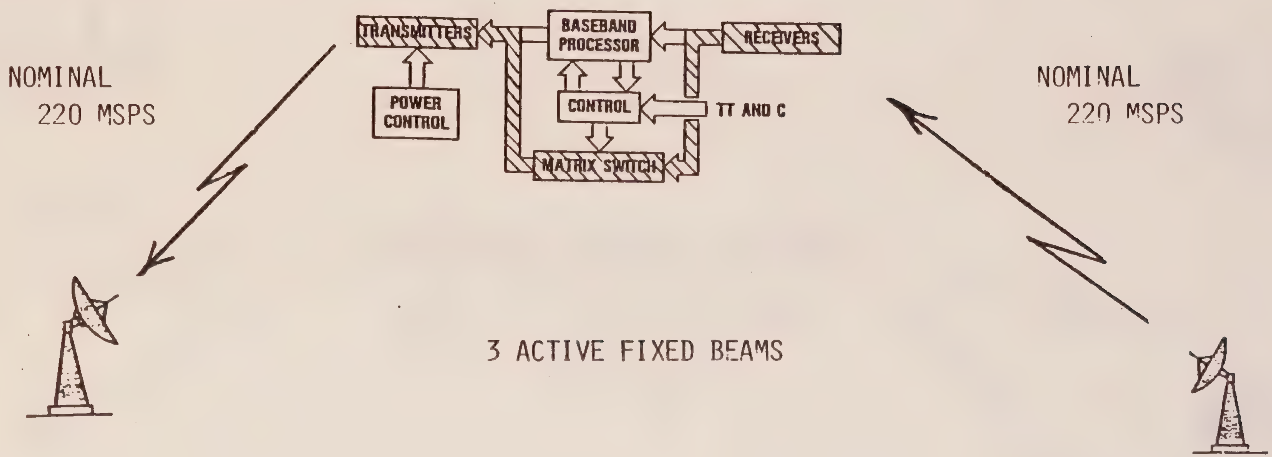
ACTS ADVANCED COMMUNICATIONS TECHNOLOGY SATELLITE

# MODES OF OPERATION



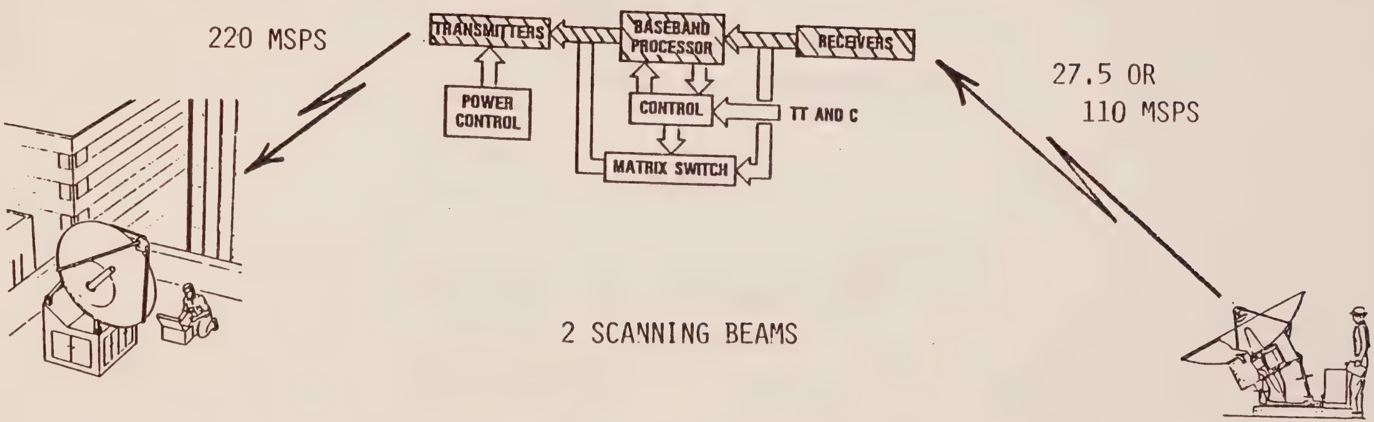

MULTIBEAM
COMMUNICATIONS
PACKAGE

## I. MATRIX SWITCH/TDMA MODE



# MODES OF OPERATION

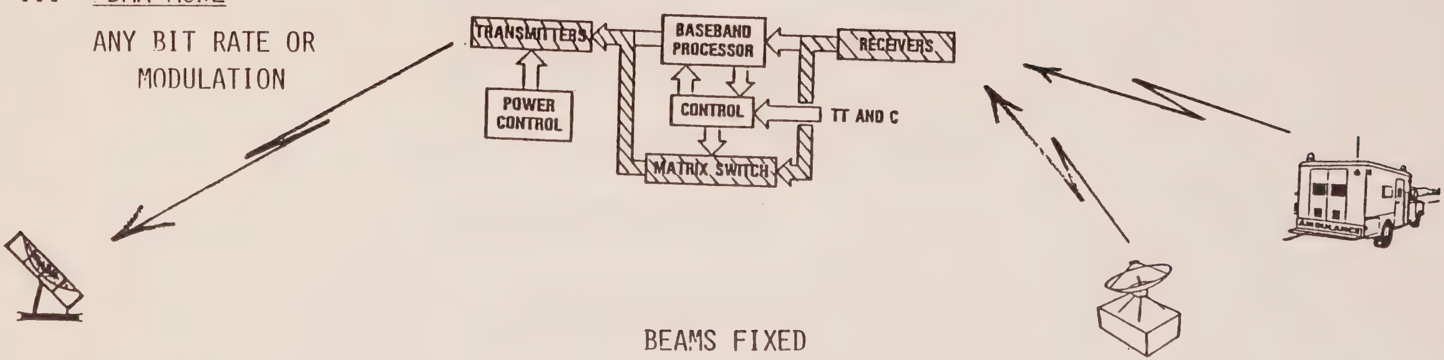
## II BASEBAND PROCESSOR/TDMA MODE




2 SCANNING BEAMS

## III FDMA MODE

ANY BIT RATE OR MODULATION




BEAMS FIXED

## POTENTIAL OPERATIONAL USES OF ACTS TECHNOLOGY

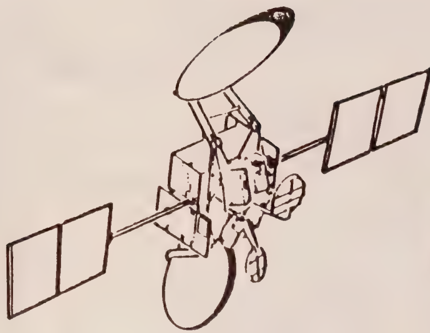
- FLEXIBLE TRUNKING
- EFFICIENT INTERNATIONAL COMMUNICATIONS
- CUSTOMER PREMISES SERVICES
  SHARED TENANT SERVICES
- RAPID DATA BASE ACCESS AND TRANSFER
  DISTRIBUTED COMPUTER PROCESSING
  ELECTRONIC DATA TRANSFER
  ELECTRONIC MAIL
- VIDEO NETWORKING
  TELECONFERENCING
  HIGH DEFINITION TELEVISION
- EMERGENCY COMMUNICATIONS RESTORATION
- MOBILE COMMUNICATIONS

NEED EXPERIMENTS TO VERIFY USES

## ACTS TECHNOLOGY EXPERIMENTS OPPORTUNITIES

- o FLIGHT SYSTEM TECHNOLOGY
  - MULTIBEAM ANTENNA
  - BASEBAND PROCESSOR
  - MATRIX SWITCH
  - TWTA'S
- o GROUND TERMINAL TECHNOLOGY
  - ANTENNAS
  - RF COMPONENTS
  - DIGITAL COMPONENTS
- o NETWORK CONTROL, ACQUISITION AND SYNCHRONIZATION
- o PROPAGATION & TRANSMISSION IMPAIRMENTS
- o RAIN COMPENSATION TECHNIQUES
- o END TO END SYSTEM TESTS

FLIGHT SYSTEM AND NASA GROUND SYSTEM
INSTRUMENTED TO PROVIDE QUANTITATIVE MEASUREMENTS

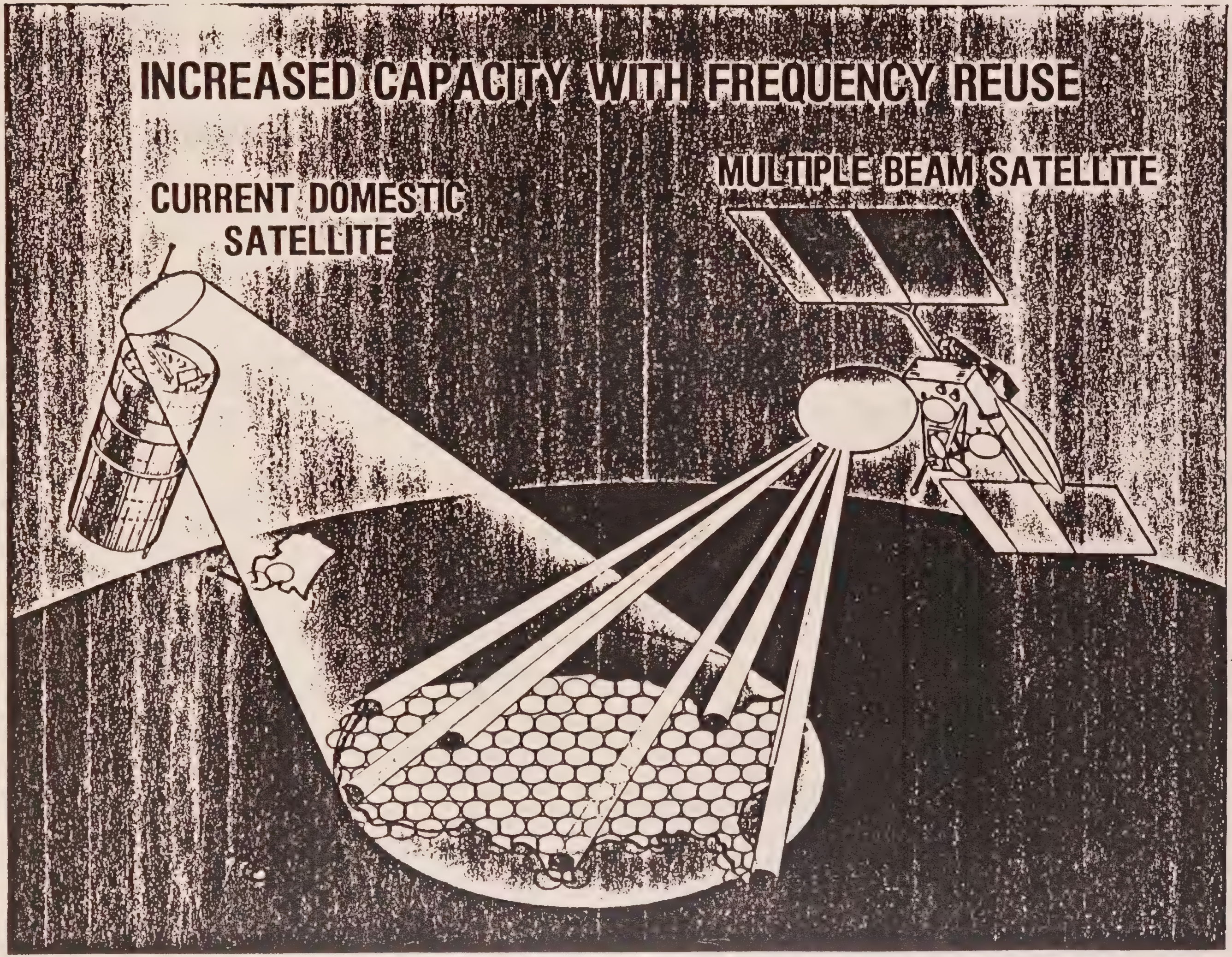


NASA
ACTS

# ADVANCED COMMUNICATIONS TECHNOLOGY SATELLITE

## ACTS COMMUNICATIONS SYSTEM

NASA
C-82-2778

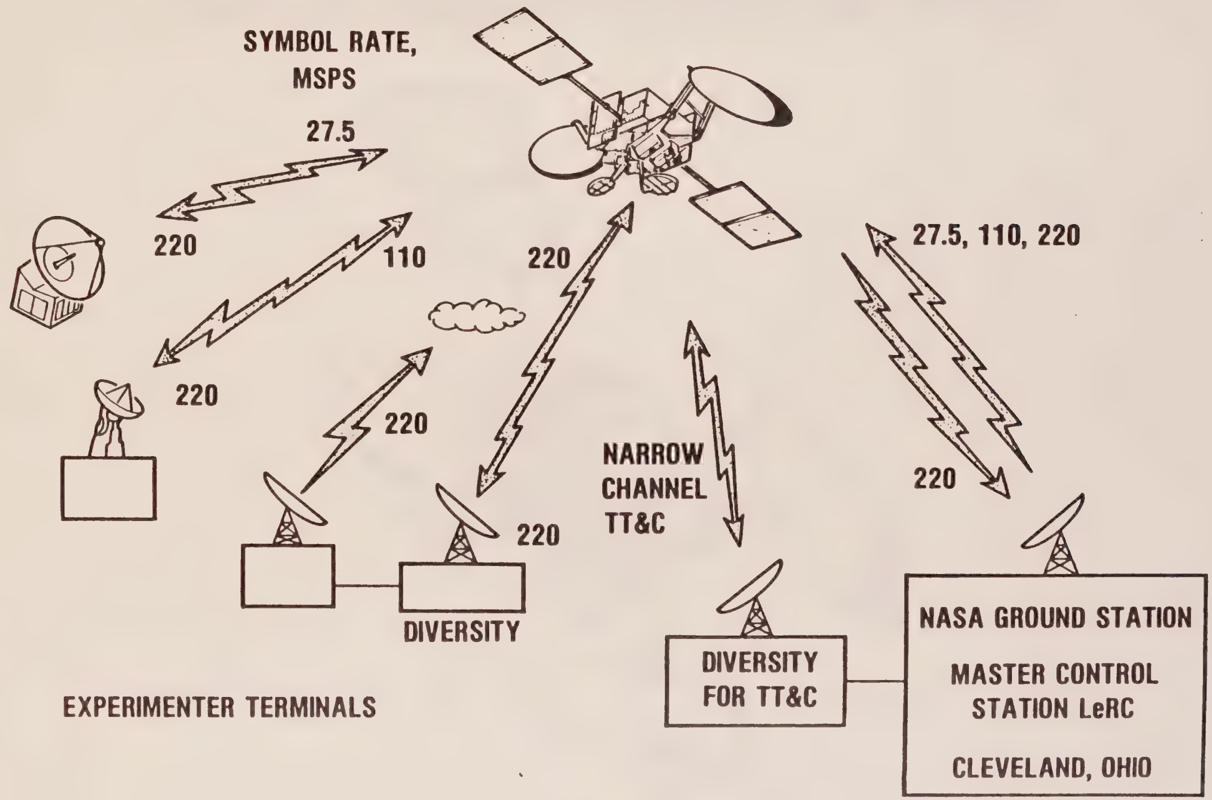


NASA
C-84-6295

NASA

ACTS ADVANCED COMMUNICATIONS TECHNOLOGY SATELLITE

# ADVANCED COMMUNICATIONS TECHNOLOGY SATELLITE SYSTEM



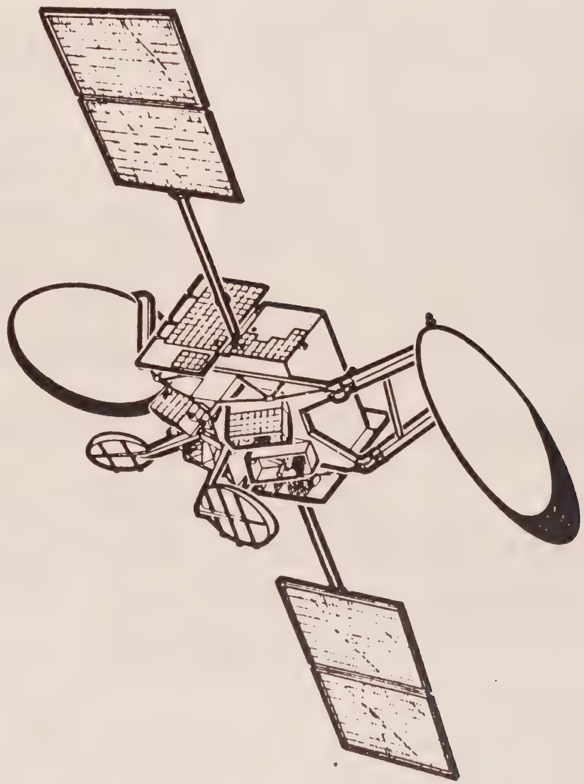

26

NASA
C-84-6299

NASA

ACTS ADVANCED COMMUNICATIONS TECHNOLOGY SATELLITE

# ACTS IN GEOSYNCHRONOUS ORBIT



27

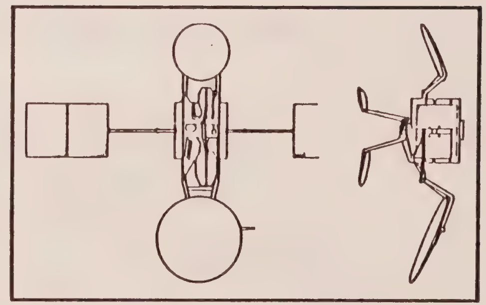
NASA
C-84-6325

NASA

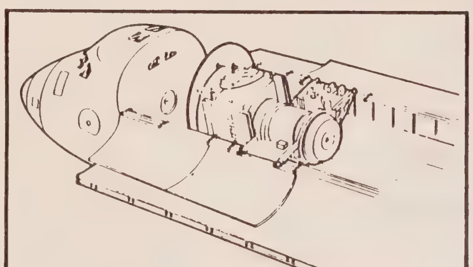
ACTS ADVANCED COMMUNICATIONS TECHNOLOGY SATELLITE

# ACTS SPACECRAFT CHARACTERISTICS

- WEIGHT: ON-ORBIT 2400 LB.
- POWER: 1660 W BOL
  SOLAR ARRAY—
  FOUR PANELS-134.5 SQ FT



  - THREE-AXIS STABILIZATION
- SPACECRAFT POINTING ACCURACY $\pm 0.05°$



- MISSION LIFE:
  2-YR EXPERIMENTS PERIOD
  4-YR ATTITUDE CONTROL PROPELLANT ALLOCATION

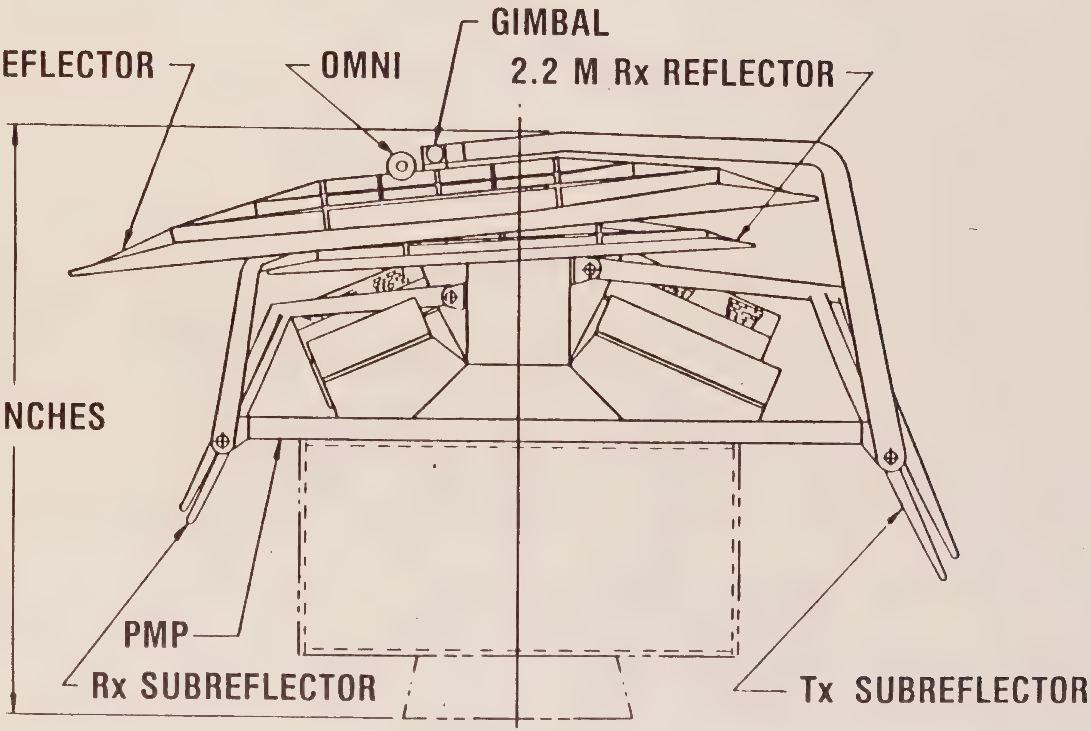
25

NASA
C-84-7352

NASA

ACTS ADVANCED COMMUNICATIONS TECHNOLOGY SATELLITE

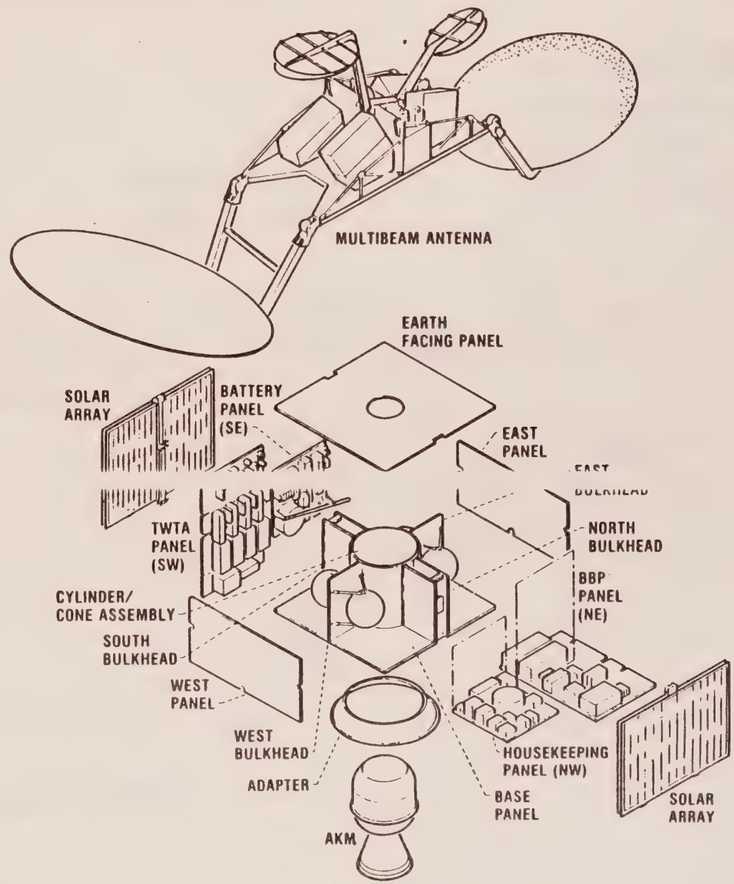
# ACTS MULTIBEAM ANTENNA IN STOWED CONFIGURATION




29

NASA
C-84-6294

# ACTS MULTIBEAM COMMUNICATIONS PACKAGE

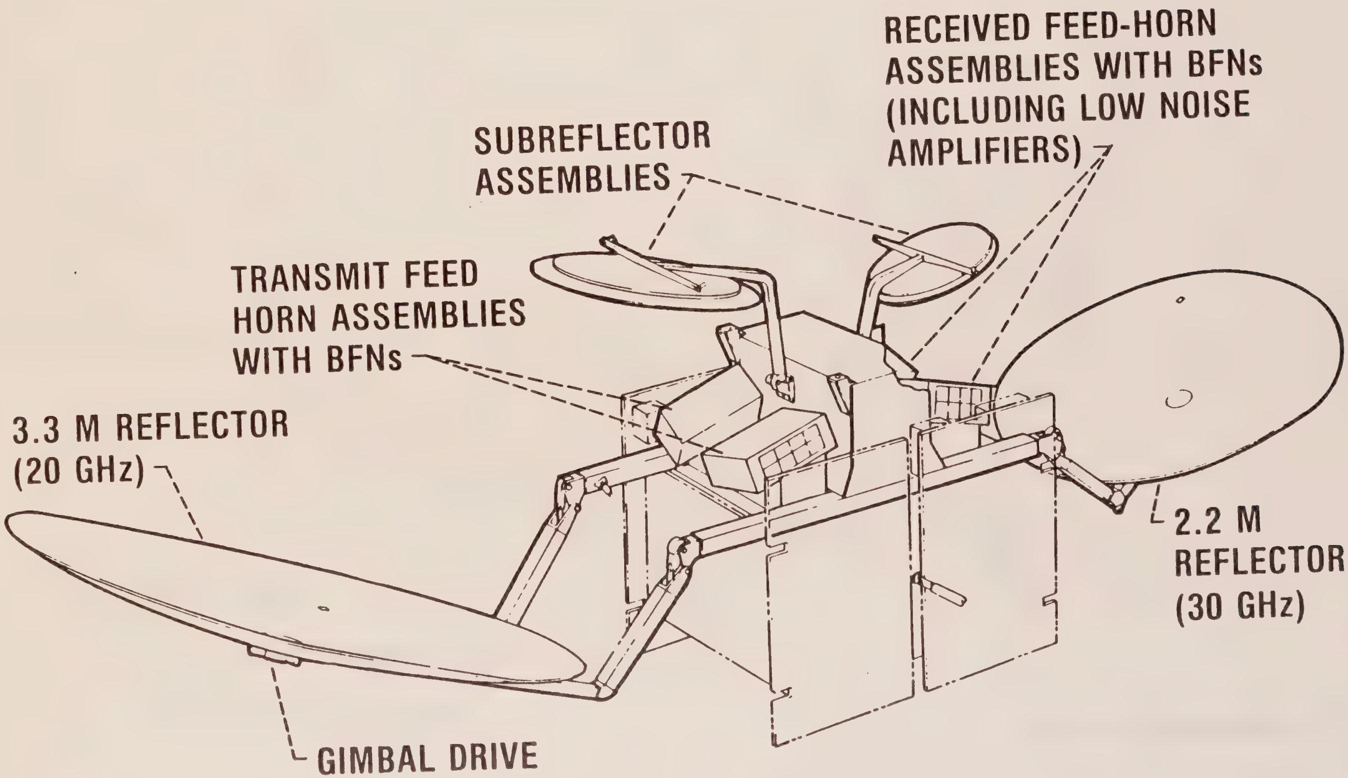


NASA
C-84-6304

NASA

ACTS ADVANCED COMMUNICATIONS TECHNOLOGY SATELLITE

# ACTS MULTIBEAM ANTENNA



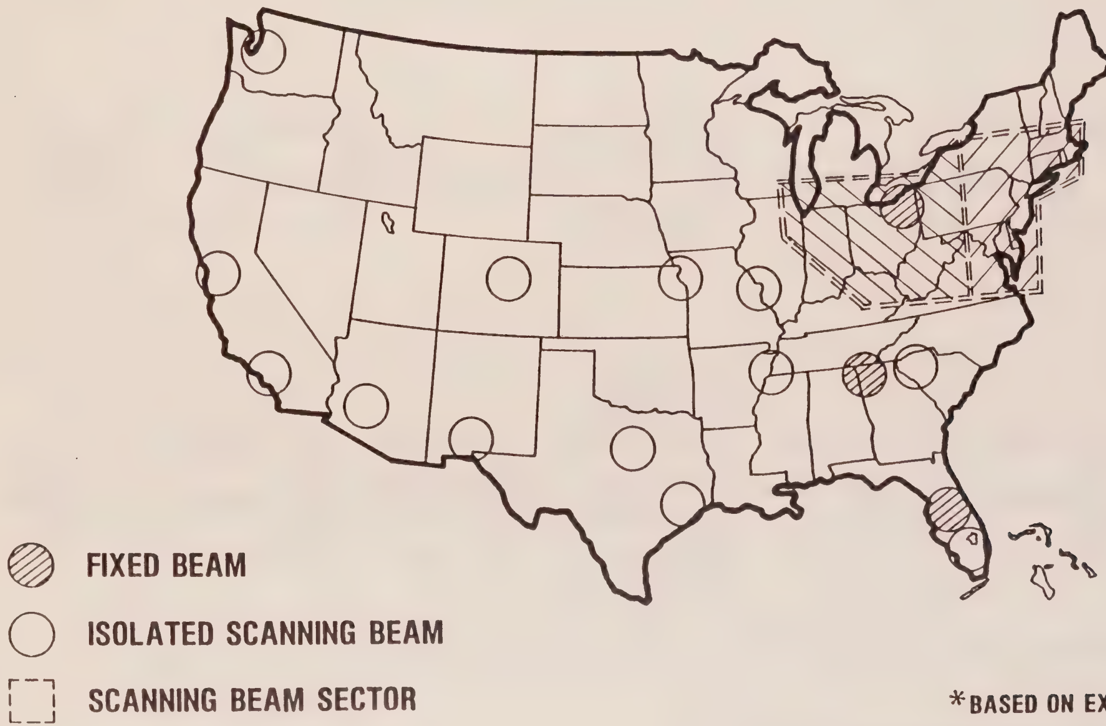

31

NASA
C-85-1972

NASA

ACTS ADVANCED COMMUNICATIONS TECHNOLOGY SATELLITE

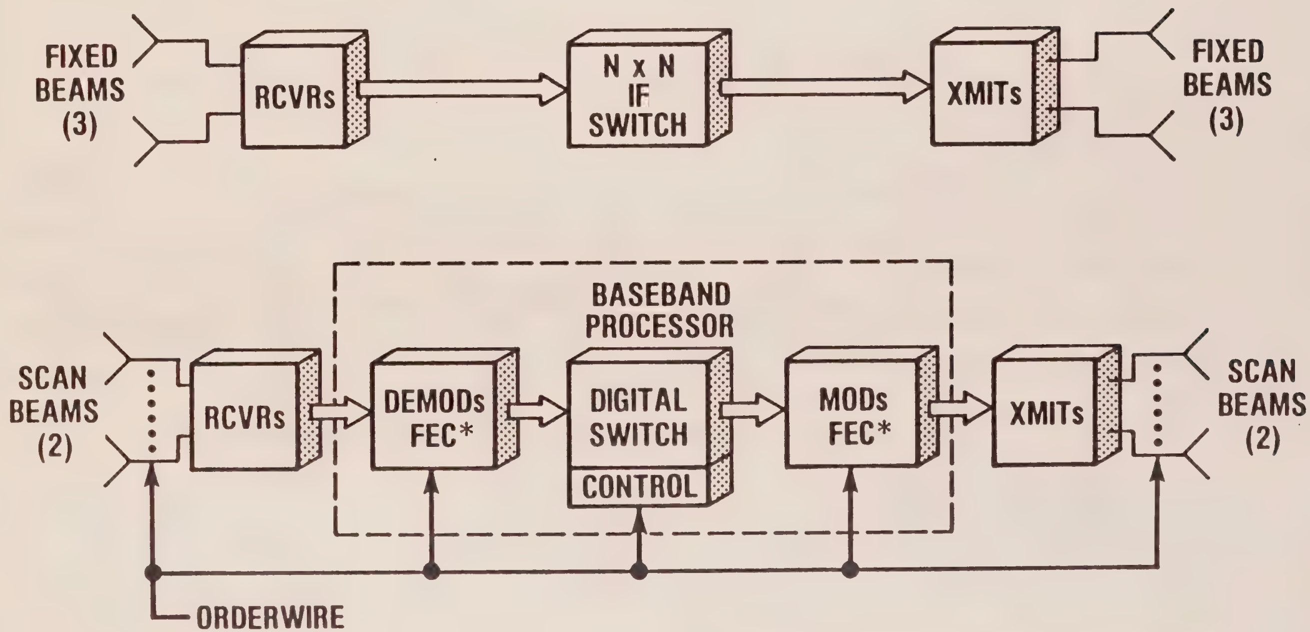
# PRELIMINARY ACTS ANTENNA COVERAGE*




*BASED ON EXPERIMENTER INPUTS

NASA
C-83-2306

# COMMUNICATIONS PAYLOAD FOR FLIGHT SYSTEM



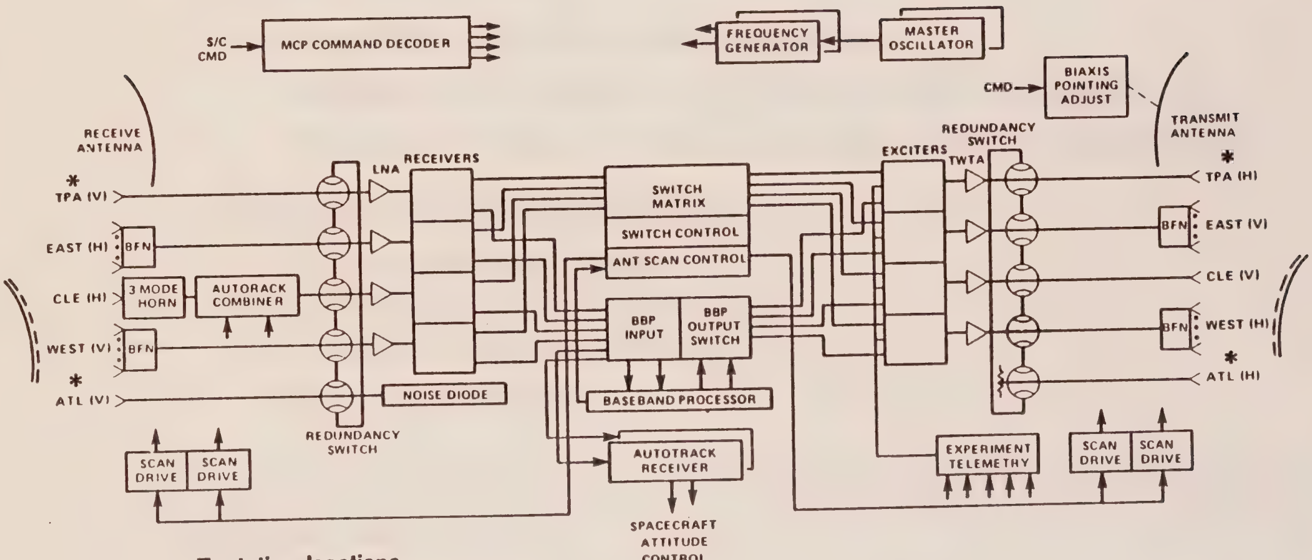

*FEC—FORWARD ERROR CORRECTION

NASA
C-84-6314

NASA

ACTS ADVANCED COMMUNICATIONS TECHNOLOGY SATELLITE

# ACTS COMMUNICATIONS PAYLOAD




* Tentative locations

34

NASA
C-84-6312

NASA

ACTS ADVANCED COMMUNICATIONS TECHNOLOGY SATELLITE

# ACTS MW MATRIX SWITCH MODE

- THREE ACTIVE BEAMS
  - USE FIXED AND/OR SCANNING BEAMS
  - NOMINAL BURST RATE—220 MSPS (UPLINK AND DOWNLINK)
  - FREQUENCY PLAN TO PROVIDE 750 MHz MINIMUM BANDWIDTH
- NOMINAL RAIN COMPENSATION
  - POWER AUGMENTATION
    SPACECRAFT (DOWNLINK) 8 dB
    GROUND TERMINAL (UPLINK) 18 dB
  - SPATIAL DIVERSITY

EXPERIMENTS POSSIBLE AT ANY BIT RATE AND MODULATION IN EITHER TDMA OR FDMA MODES

NASA
C-84-6326

NASA

ACTS ADVANCED COMMUNICATIONS TECHNOLOGY SATELLITE

# ACTS BASEBAND PROCESSOR MODE

- TWO SCANNING BEAMS
  - CHANNELS/BEAM
  - UPLINK—FOUR 27.5 MSPS OR TWO 110 MSPS
    FDM/TDMA CHANNELS
  - DOWNLINK—ONE 220 MSPS CHANNEL

- NOMINAL RAIN COMPENSATION
  - FORWARD ERROR CORRECTION
    - RATE 1/2, CONSTRAINT LENGTH 5, CONVOLUTION ENCODING
    - TWO LEVEL SOFT DECISION DECODING
  - RATE REDUCTION OF 1/2

| |
|---|
| DESIGNED FOR LOW COST TERMINALS WITH INDIVIDUAL CIRCUIT (64 KBPS) ROUTING VIA BASEBAND PROCESSOR |

NASA
C-84-6317

NASA

ACTS ADVANCED COMMUNICATIONS TECHNOLOGY SATELLITE

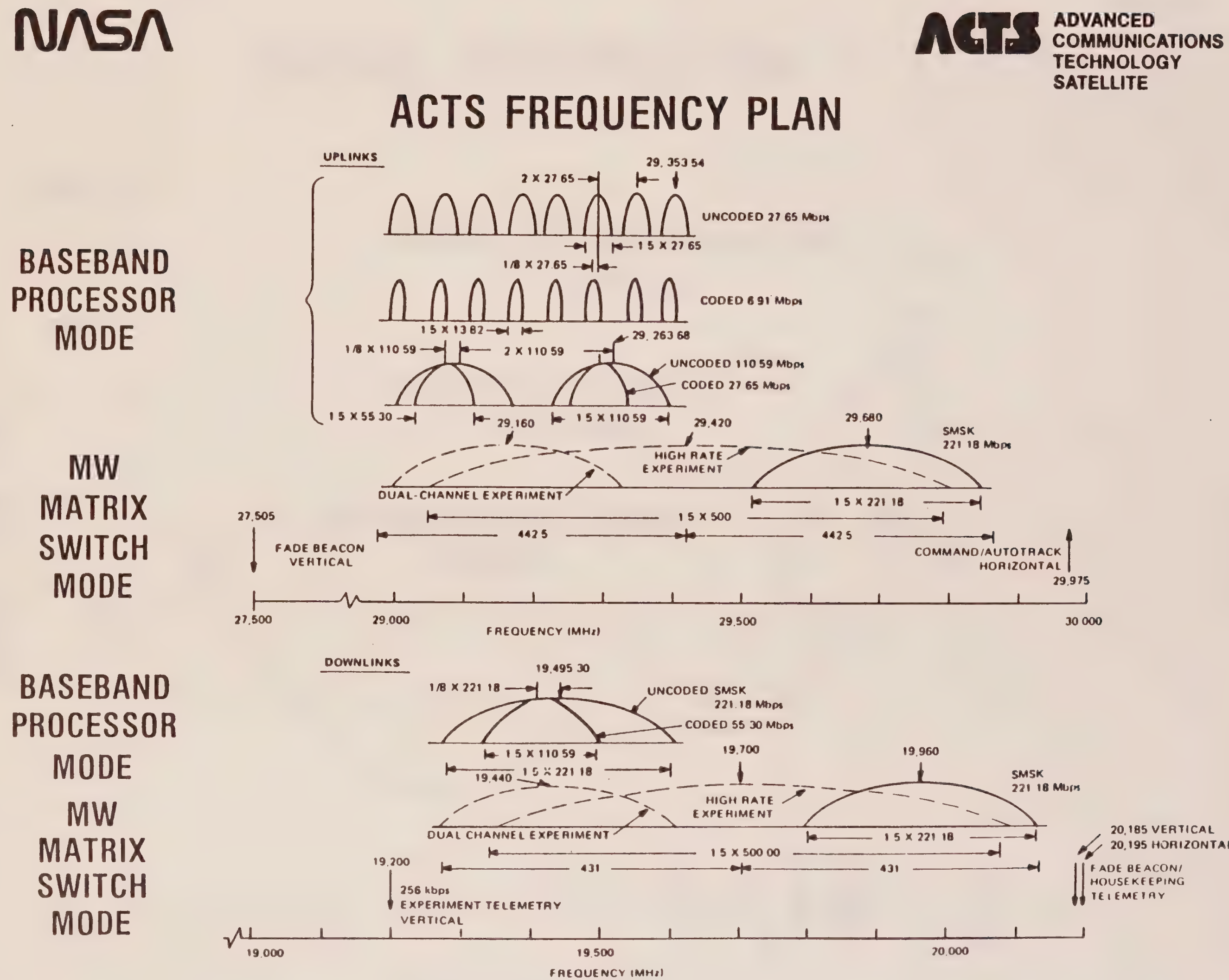
# BASEBAND PROCESSOR MODE LINK RATES/CODING ADAPTATION

| LINK | LINK CONDITION | INFORMATION BIT RATE, Mbps | CODED SYMBOL RATE, Msps | BURST SYMBOL RATE, Msps | $C/N_0$ ADVANTAGE |
|---|---|---|---|---|---|
| UP | CLEAR SKY | 110/27.5 | ---- | 110/27.5 | ---- |
| | RAIN | 27.5/6.875 | 55/13.75 | 55/13.7 | 10 dB* |
| DOWN | CLEAR SKY | 220 | ---- | 220 | ---- |
| | RAIN | 55 | 110 | 110 | 10 dB* |

*ASSUMES 4.0 dB FEC GAIN AT $1 \times 10^{-6}$ BER. RF BANDWIDTH IS $1.5 \times$ BURST SYMBOL RATE.

NASA
C-84-6320

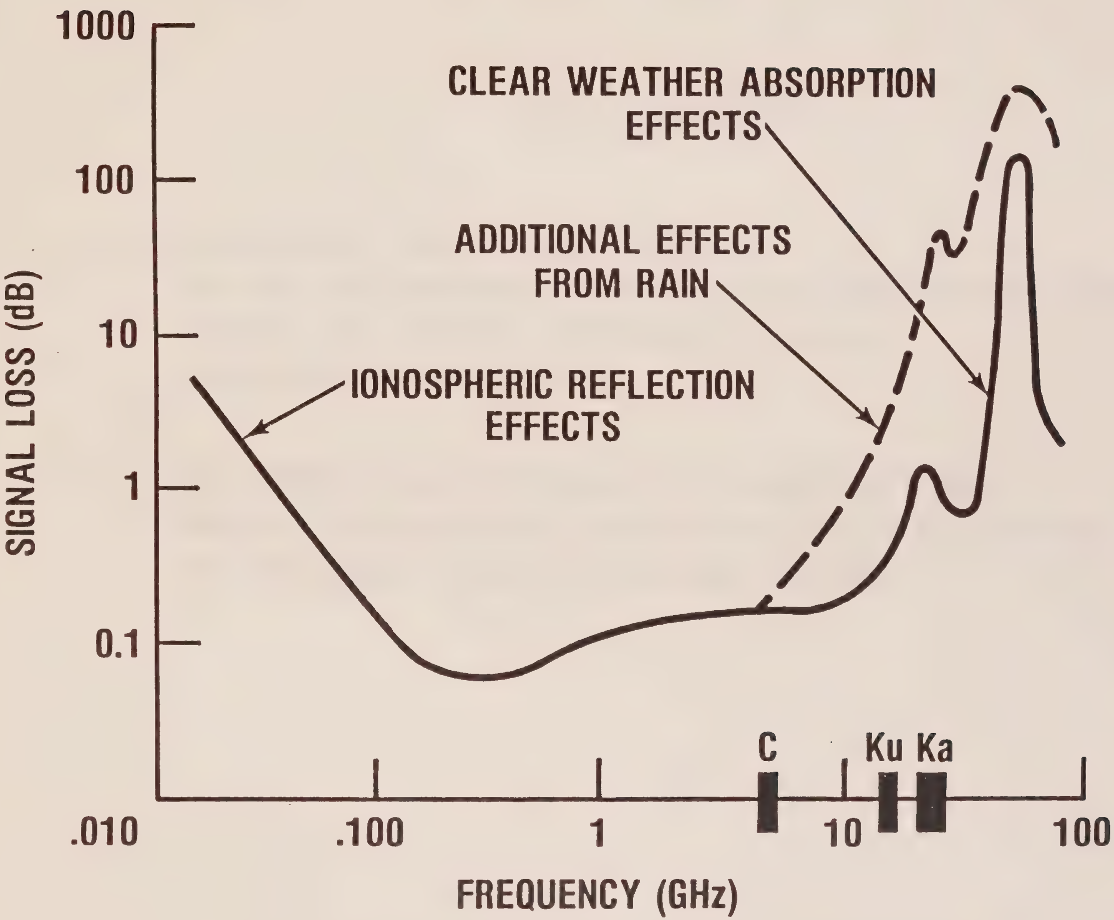
# ACTS FREQUENCY PLAN




38

NASA

# SIGNAL ATTENUATION



NASA
C-84-6313

NASA

ACTS ADVANCED COMMUNICATIONS TECHNOLOGY SATELLITE

# FADE SENSING

- MEASURED AT BOTH 30 AND 20 GHz
  USE S/C BUS HOUSEKEEPING TT & C BEACON CARRIERS AT 20 GHz
  SPECIAL FADE BEACON PROVIDED AT 30 GHz
  CONUS ANTENNA COVERAGE

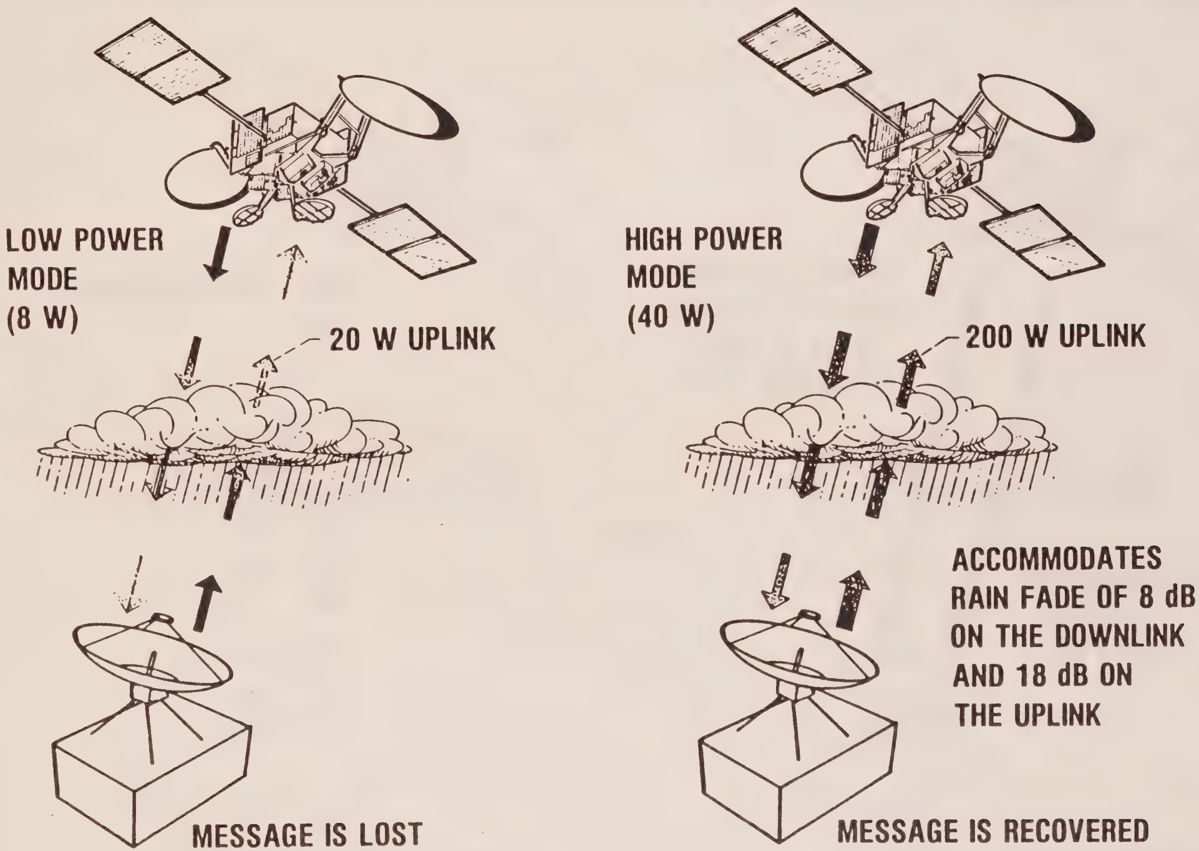
- FADE MEASUREMENT AT EACH EXPERIMENTER STATION
  BOTH AT 20 AND 30 GHz, SAMPLED EVERY 32 MSEC, RETURN DATA
  VIA ORDERWIRE TO MASTER CONTROL STATION

NASA
C-84-6333

NASA

ACTS ADVANCED COMMUNICATIONS TECHNOLOGY SATELLITE

# POWER CONTROL FOR SIGNAL LOSS IN RAIN



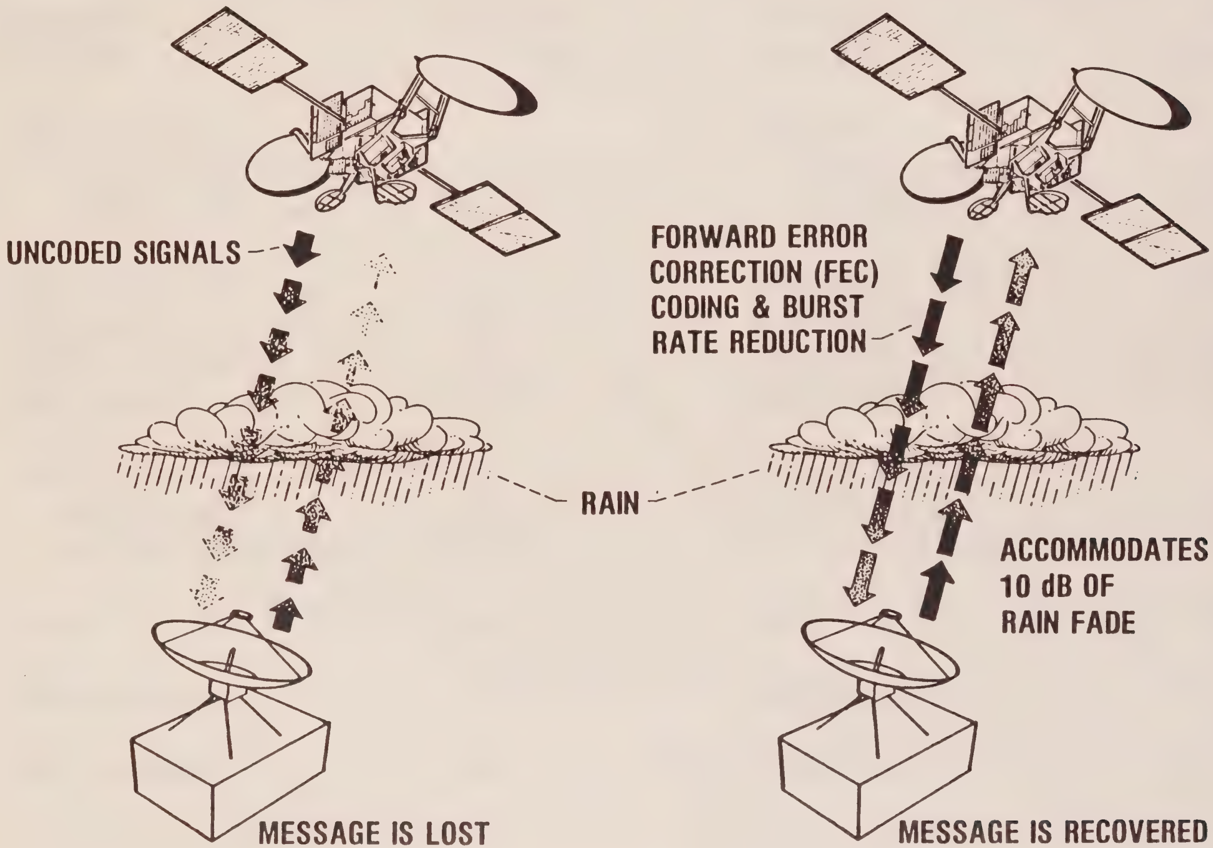

+

NASA
C-84-6332

NASA

ACTS ADVANCED COMMUNICATIONS TECHNOLOGY SATELLITE

# FORWARD ERROR CORRECTION FOR SIGNAL LOSS IN RAIN




42

## TYPICAL LBR LINK BUDGET FOR CLEAR SKY

| UPLINK | | DOWNLINK | |
|---|---|---|---|
| FREQUENCY | 29.4 GHz | FREQUENCY | 19.7 GHz |
| DATA RATE | 27.5 MBPS | DATA RATE | 220.0 MBPS |
| EARTH STATION | | SATELLITE | |
| TRANSMIT POWER (10W) | 10.0 DBW | TRANSMIT POWER (40W) | 16.0 DBW |
| ANTENNA GAIN (3M) | 57.1 | ANTENNA GAIN (2.2M) | 48.0 |
| PROPAGATION LOSS | - 213.4 | PROPAGATION LOSS | - 209.9 |
| RAIN MARGIN | - 5.0 | RAIN MARGIN | - 3.0 |
| IMPLEMENTATION LOSS | - 3.0 | IMPLEMENTATION LOSS | - 3.0 |
| OTHER LOSSES | - 3.2 | OTHER LOSSES | - 2.5 |
| SATELLITE | | EARTH STATION | |
| ANTENNA GAIN | 48.0 | ANTENNA GAIN | 53.2 |
| RECEIVED NOISE POWER | - 124.6 | RECEIVED NOISE POWER | - 113.9 |
| $E_B/N_O$ | 15.1 | $E_B/N_O$ | 12.7 |
| REQUIRED $E_B/N_O$ | 10.9 | REQUIRED $E_B/N_O$ | 10.9 |
| EXCESS MARGIN | 4.2 | EXCESS MARGIN | 1.8 |

NASA
C-84-6319

NASA

ACTS ADVANCED COMMUNICATIONS TECHNOLOGY SATELLITE

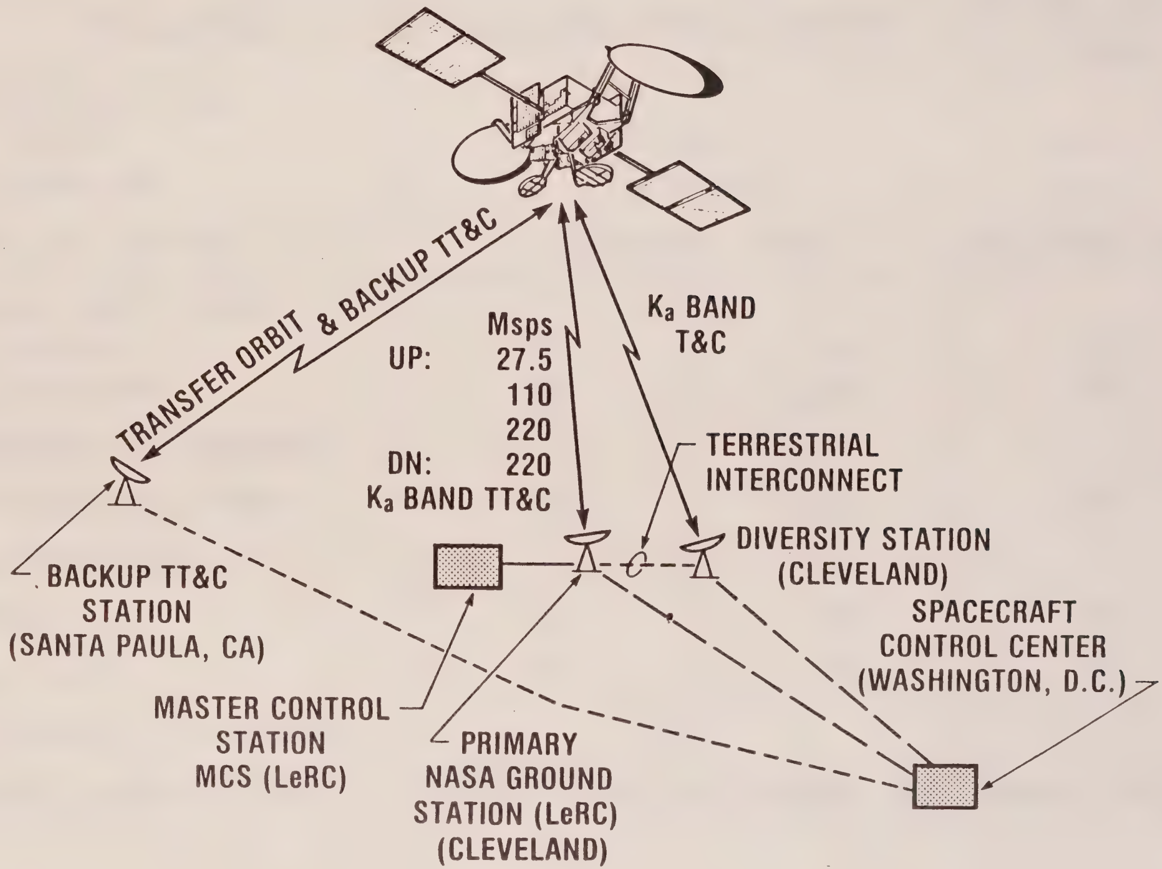
# NASA GROUND SYSTEM

- NASA GROUND STATION-PRIMARY
- MASTER CONTROL STATION
- DIVERSITY STATION (TT&C ONLY)
- SATELLITE CONTROL CENTER
- ON-ORBIT C-BAND BACKUP STATION
- TRANSFER ORBIT STATION
- TERRESTRIAL INTERCONNECT
  (9600 BPS LAND LINE)

NASA
C-84-6296

ACTS ADVANCED COMMUNICATIONS TECHNOLOGY SATELLITE

# ACTS GROUND SYSTEM



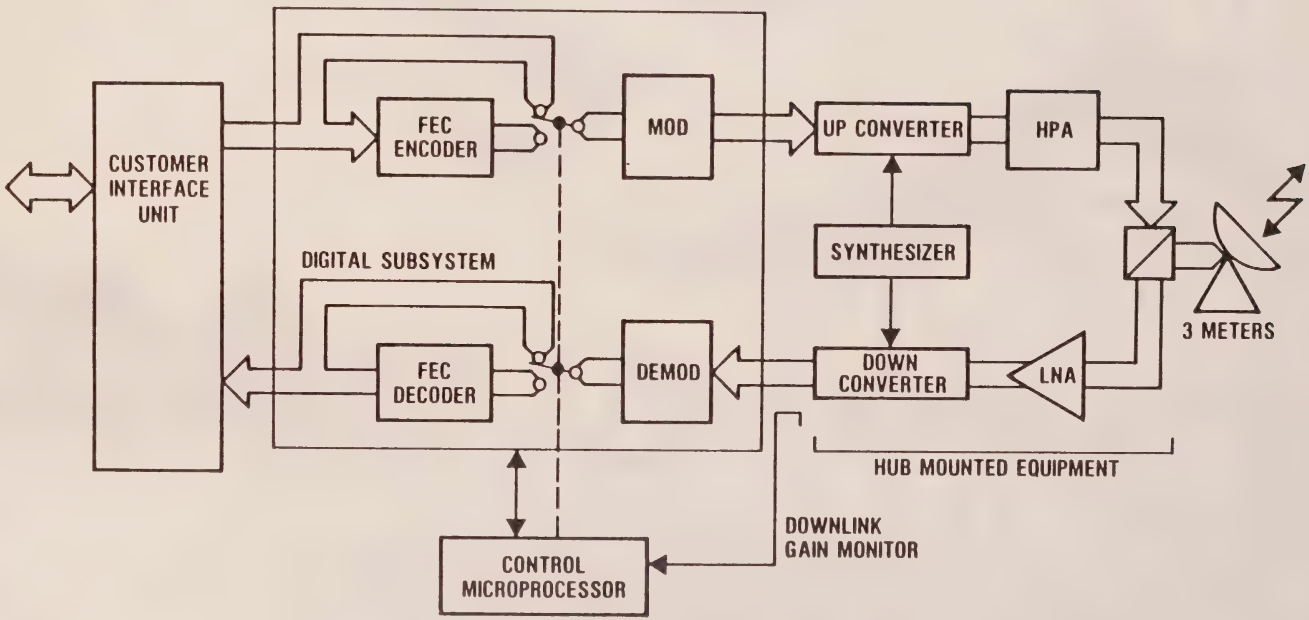

45

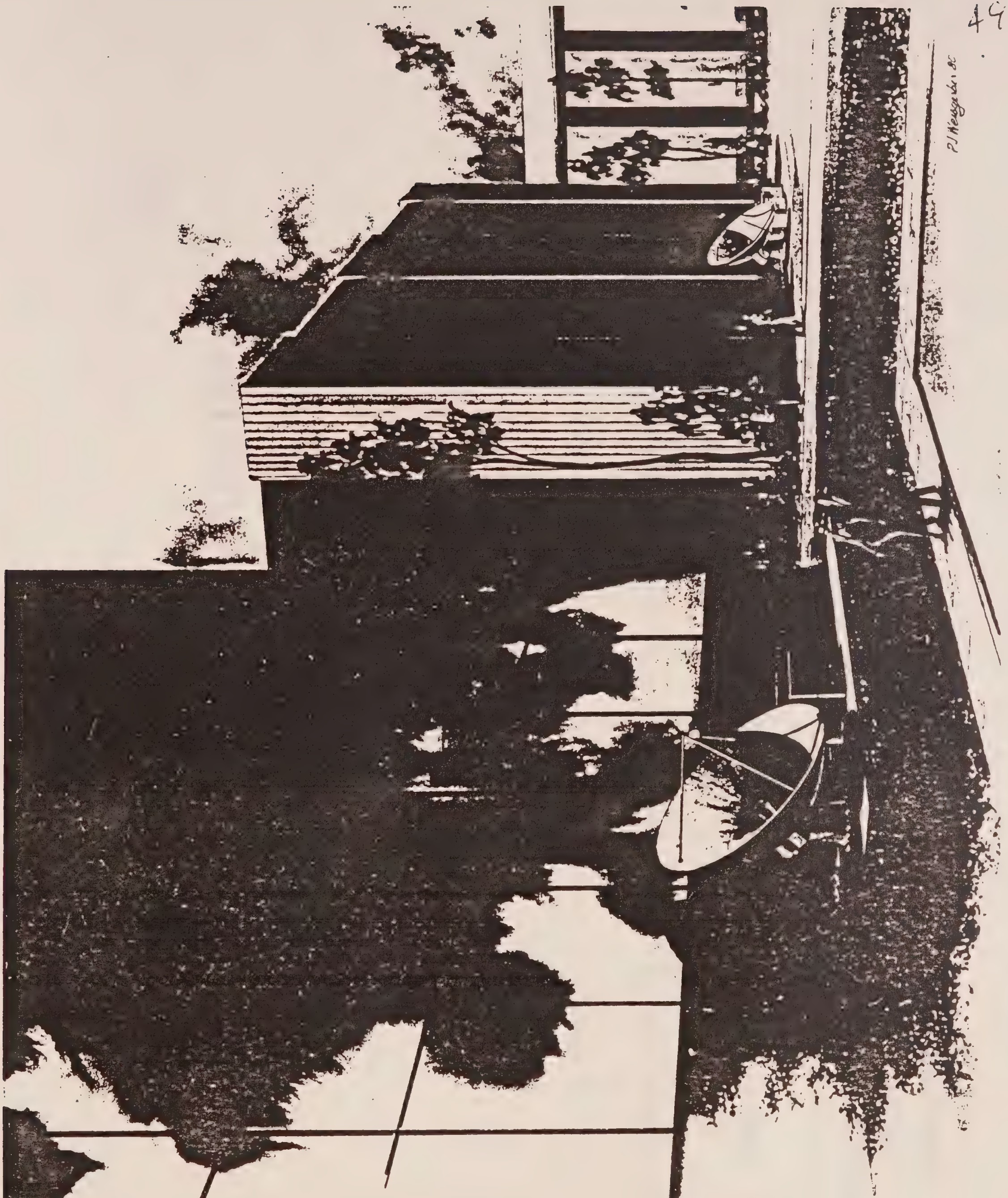
# BASELINE ACTS GROUND TERMINAL CHARACTERISTICS

| PARAMETER | BASEBAND PROCESSOR MODE | | MATRIX SWITCH MODE |
|---|---|---|---|
| FREQUENCY GHz<br>UPLINK<br>DOWNLINK | 27.5–30.0<br>17.7–20.02 | | ———<br>——— |
| ACCESS METHOD | FDM/TDMA, DAMA | | SS-TDMA, DAMA |
| BURST RATE, MSPS<br>UPLINK<br>DOWNLINK | 27.5<br>220 | 110<br>220 | 220<br>220 |
| NUMBER OF CHANNELS | 4 | 1 | 1 |
| THROUGHPUT, MBPS | 110 | 110 | 220 |
| ANTENNA SIZE, m | 3 | 5 | 5 |
| HPA, W | 10 | 20 | 250 |
| G/T, dB/K | 22 | 27 | 27 |
| NOMINAL BIT ERROR RATE | $10^{-6}$ | | $10^{-6}$ |
| FADE COMPENSATION | FEC AND BURST RATE REDUCTION | | POWER CONTROL |

NASA

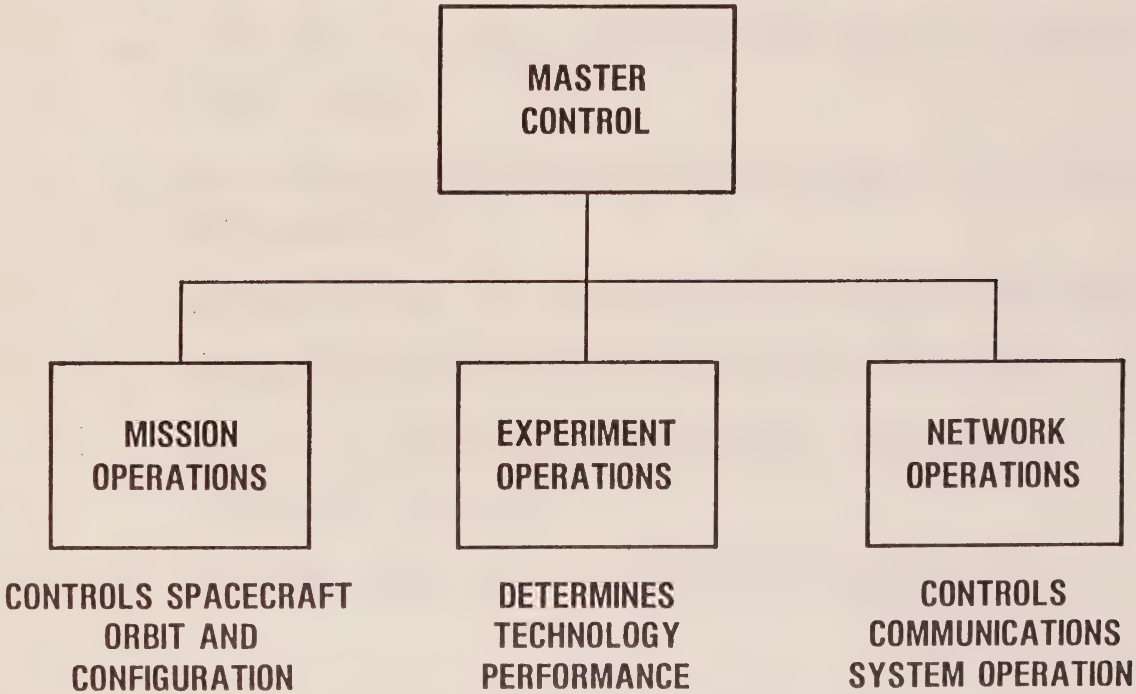
# TYPICAL LOW BURST RATE TERMINAL SCHEMATIC





NASA

# MASTER CONTROL STATION FUNCTIONS




52

NASA
C-84-6322

NASA

ACTS ADVANCED COMMUNICATIONS TECHNOLOGY SATELLITE

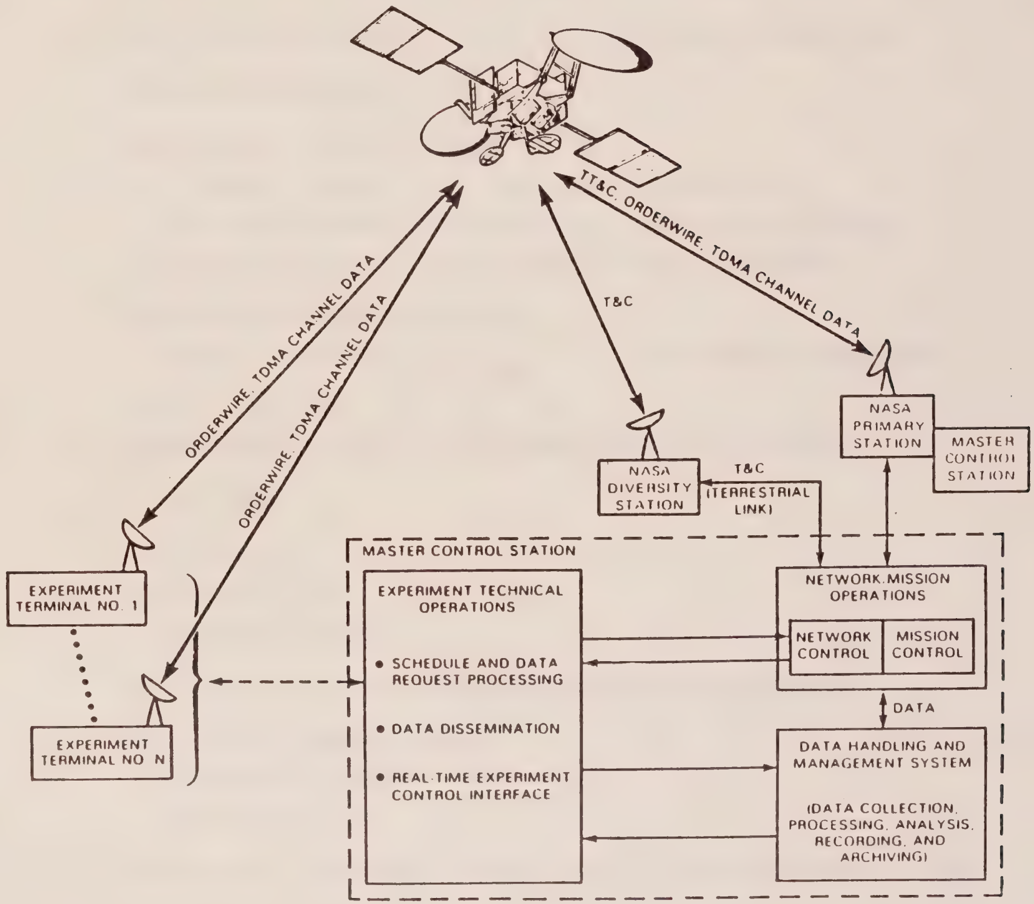
# ACTS MASTER CONTROL STATION WILL

- MONITOR STATIONKEEPING AND ORBIT CONTROL FUNCTIONS
- SET CONFIGURATIONS OF ON-BOARD SWITCHING MECHANISMS
- AUTOMATICALLY HANDLE RAIN COMPENSATION
- COORDINATE GROUND TERMINAL NETWORK
- CONTROL SEQUENCE AND DWELL TIMING OF SCANNING BEAMS
- CONTROL MW MATRIX SWITCH SEQUENCE

NASA

ACTS ADVANCED COMMUNICATIONS TECHNOLOGY SATELLITE

# ACTS EXPERIMENT OPERATIONS



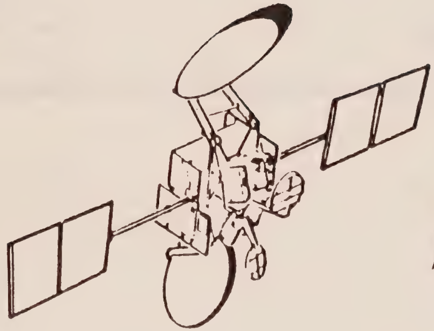

52

NASA

ACTS ADVANCED COMMUNICATIONS TECHNOLOGY SATELLITE

# COMMUNICATION SYSTEMS CHARACTERISTICS

- 27.5-30.0 GHz UPLINK    17.7-20.2 GHz DOWNLINK
- TDMA WITH DAMA
- MW MATRIX SWITCH MODE
  220 MSPS UPLINK    220 MSPS DOWNLINK
  (NOTE-EXPERIMENTS POSSIBLE AT ANY BIT RATE AND MODULATION IN EITHER TDMA OR FDMA FORMAT)
- BASEBAND PROCESSOR MODE
  $\left.\begin{array}{l}\text{FOUR-27.5 MSPS}\\ \text{ONE - 110 MSPS}\end{array}\right\}$ UPLINK    220 MSPS DOWNLINK
- SMSK MODULATION IN BASEBAND PROCESSOR MODE
- $\leq 10^{-6}$ BER
- FADE MARGIN
  18 dB UPLINK
  8 dB DOWNLINK
- FADE SENSING 20 AND 30 GHz DOWNLINK BEACONS
- 20 GHz DUAL MODE TWTA
  HIGH POWER 40 W
  LOW POWER 8 W
- 30 GHz FET LOW NOISE AMPLIFIER-4.5 dB MAX NOISE FIGURE



NASA ACTS

# ADVANCED COMMUNICATIONS TECHNOLOGY SATELLITE

## GROUND TERMINALS

57

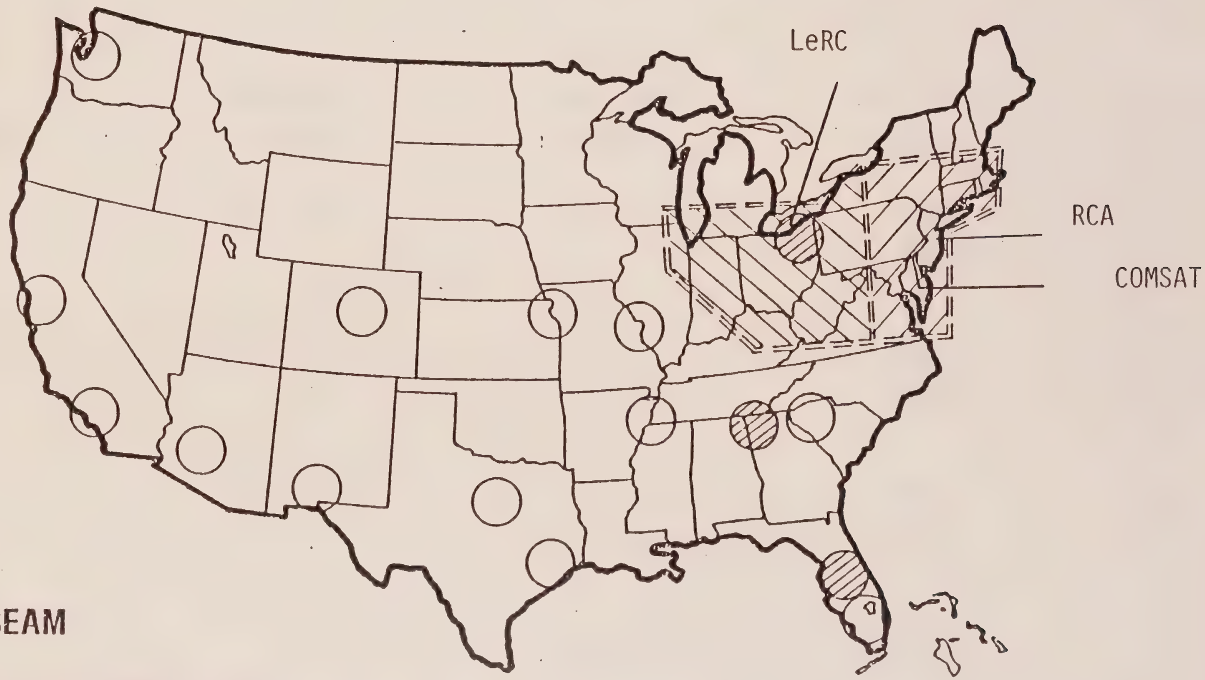
GROUND TERMINALS

- THE ACTS EXPERIMENTER GROUND TERMINAL FAMILY
- ON-GOING TECHNOLOGY DEVELOPMENT ACTIVITIES
    - COMPONENTS
    - TERMINALS
- COSTS
- NASA'S PROGRAM FOR ACTS EXPERIMENT TERMINALS

NASA

ACTS ADVANCED COMMUNICATIONS TECHNOLOGY SATELLITE

# PRELIMINARY ACTS ANTENNA COVERAGE*




FIXED BEAM

ISOLATED SCANNING BEAM

SCANNING BEAM SECTOR

CD-85-15826

*BASED ON EXPERIMENTER INPUTS

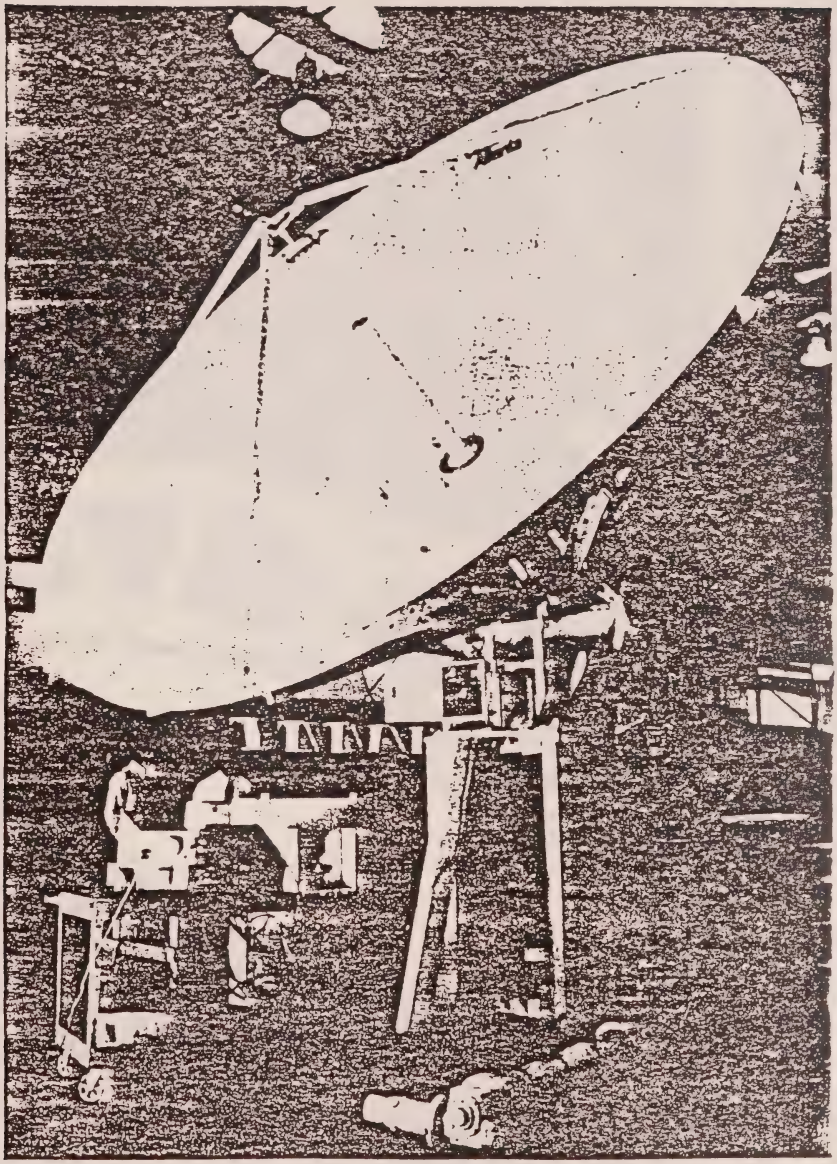
56

# THE ACTS GROUND TERMINALS

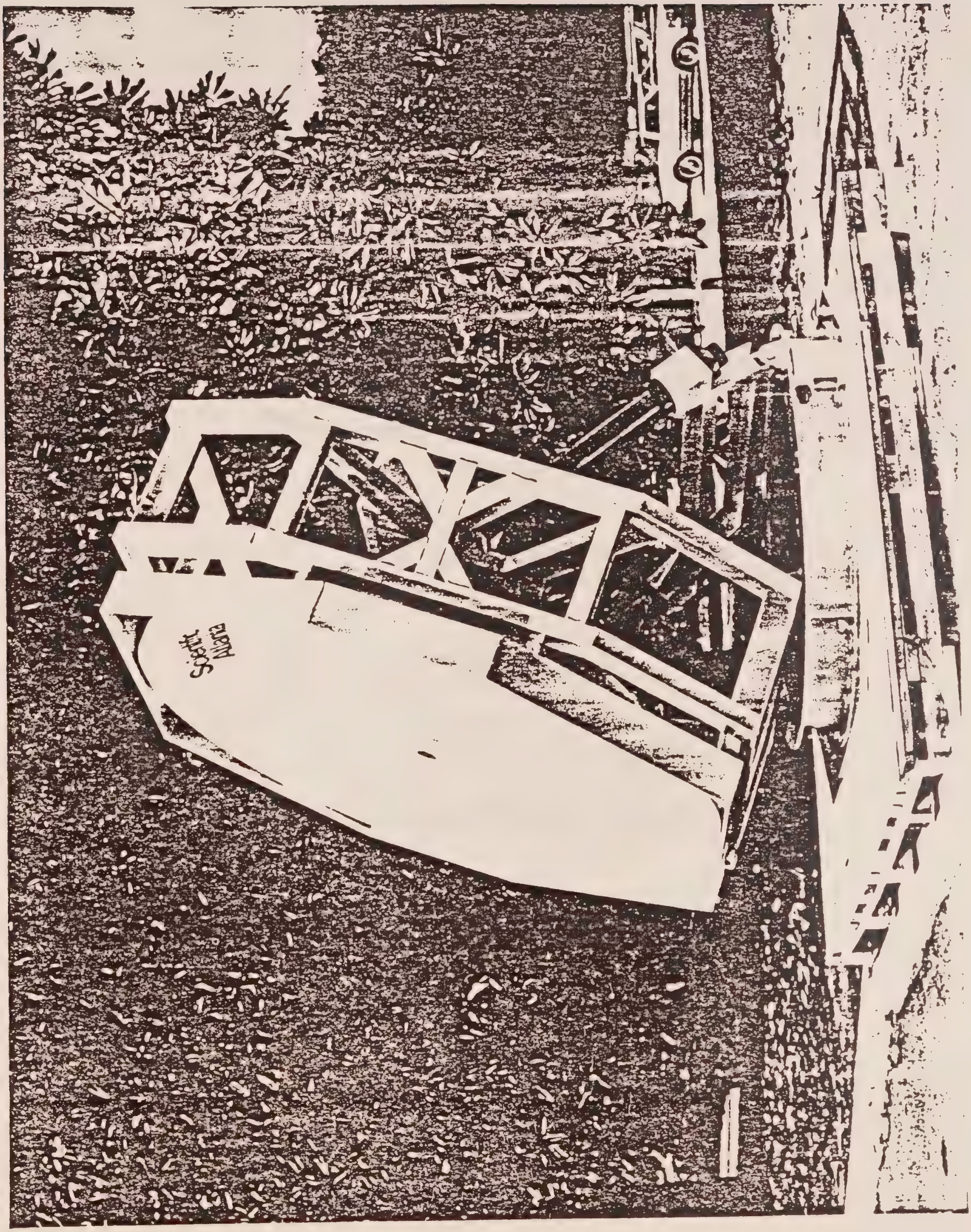
## - POTENTIAL FAMILY MEMBERS -

| TYPE | THROUGHPUT (MBS) | UPLINK BURST RATE (MBPS) | ACCESS METHOD | ANTENNA DIA (M) |
|---|---|---|---|---|
| HBR | 1 CH @ 220 | 220 | TDMA (IF SWITCH) | 5 |
| LBR (110) | 1 CH @ 110 | 110 | TDMA (BBP) | 5 |
| LBR (27.5) | 1 CH @ 27.5 | 27.5 | TDMA (BBP) | 3 |
| LBR (.056) | 1 CH @ .056 | .056 (CONTINUOUS) | FDMA (IF SWITCH) | 1.5 |

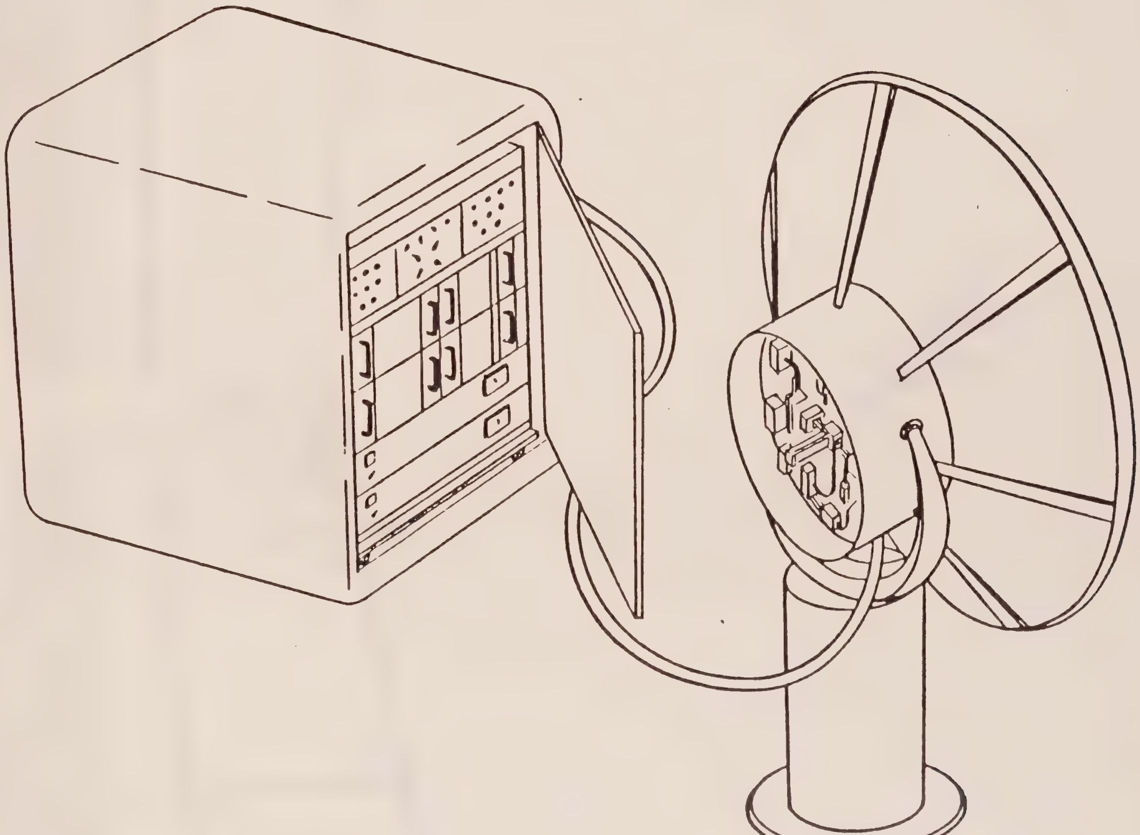
OTHERS -- TBD BASED ON EXPERIMENTER INPUTS



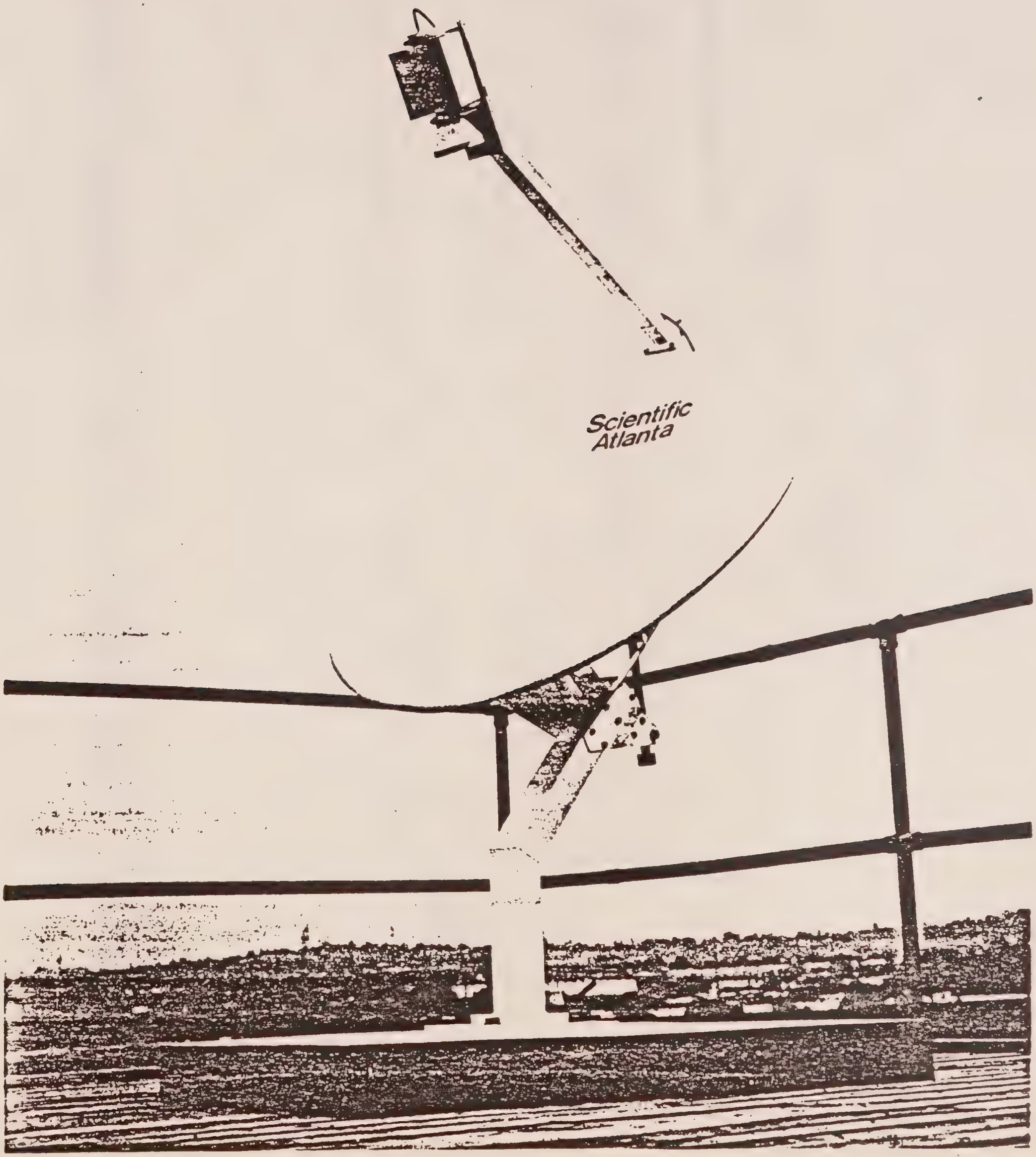
4.7 METER ANTENNA



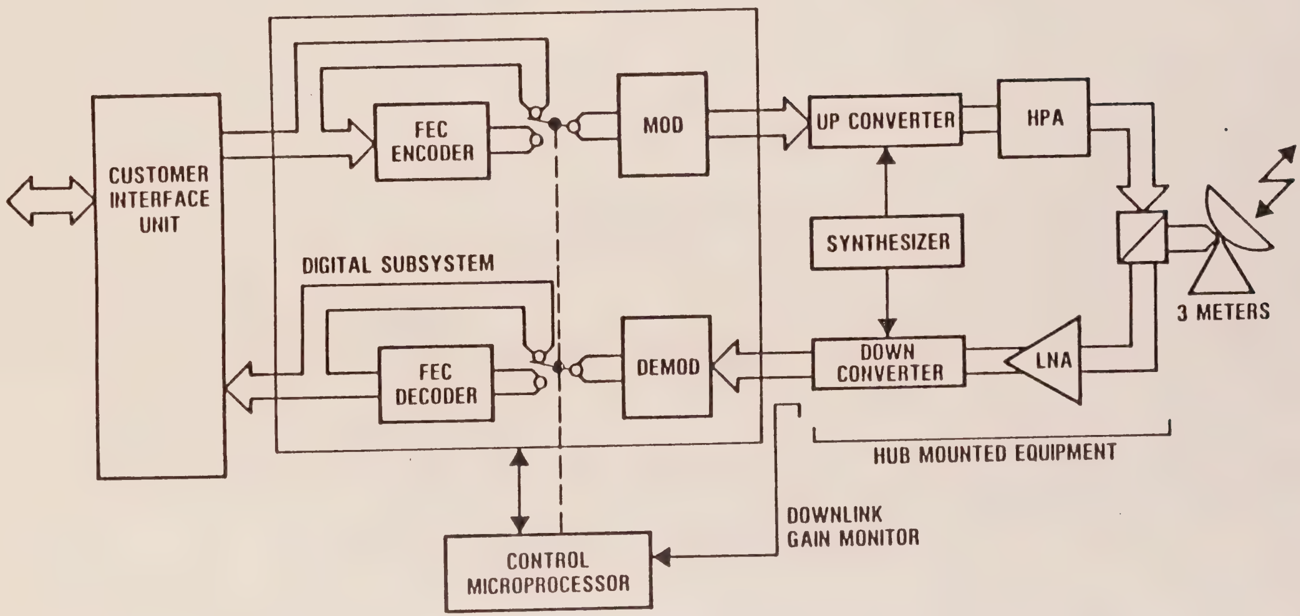
# 3 METER-30 MSPS BURST RATE TERMINAL



60


Scientific
Atlanta

# TYPICAL LOW BURST RATE TERMINAL SCHEMATIC



# GROUND TERMINAL COMPONENT DEVELOPMENT
## ACTIVITY APPLICABLE TO ACTS

1) LeRC IN-HOUSE
   - RF
     - ANTENNAS
     - 20 GHz RECEIVER
     - 30 GHz SOLID STATE HPA
   - DIGITAL
     - MODULATOR-DEMODULATOR
     - ENCODER/DECODER

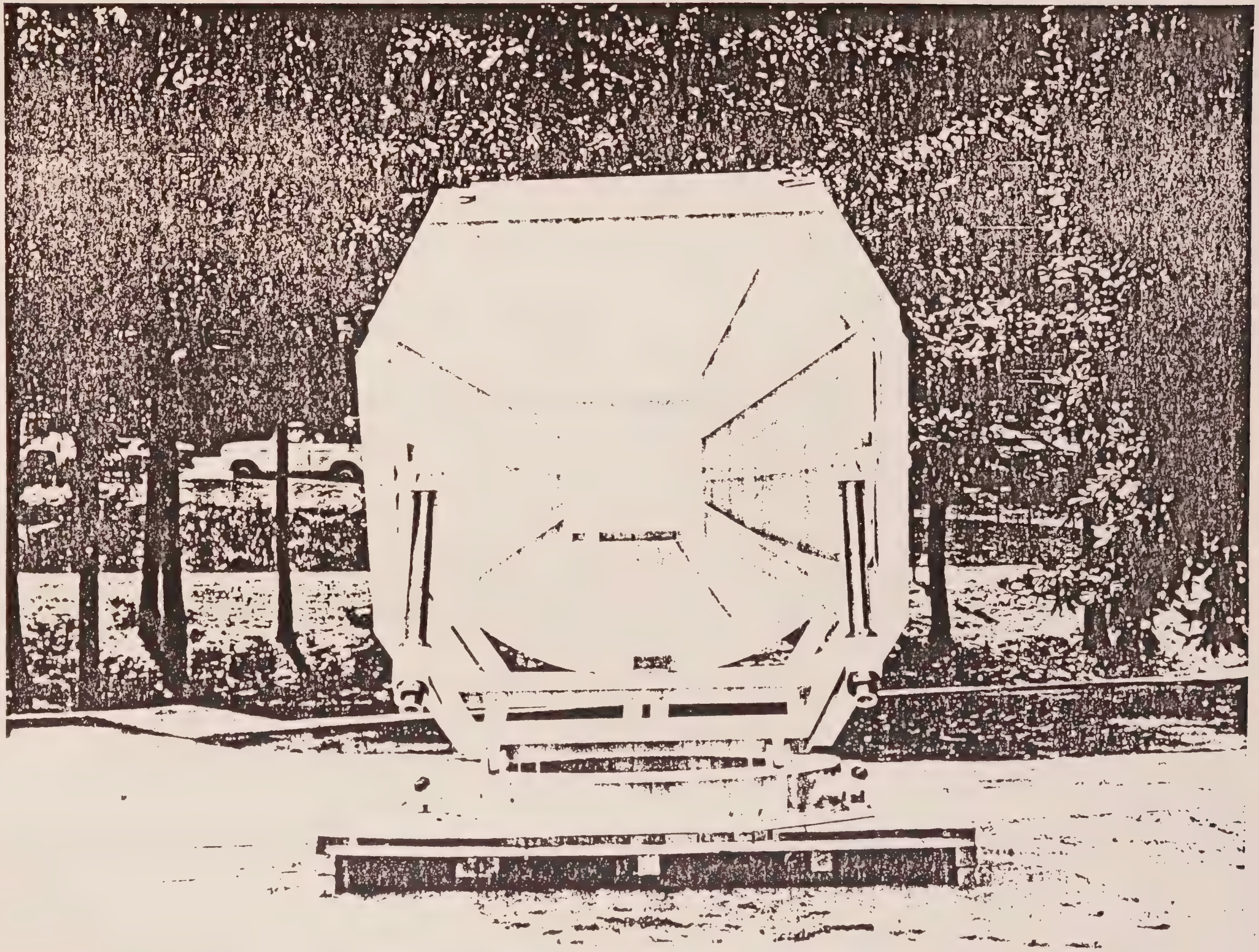
2) MILSTAR
   - RF COMPONENTS MAY APPLY

3) ACTS CONTRACT
   - ALL NGS, RF, & DIGITAL

4) COMSAT EXPERIMENTER TERMINAL
   - ALL LBR

5) RCA EXPERIMENTER TERMINAL
   - ALL HBR/LBR

NASA
C-84-6959



64

# 20 GHz RECEIVER

OBJECTIVES

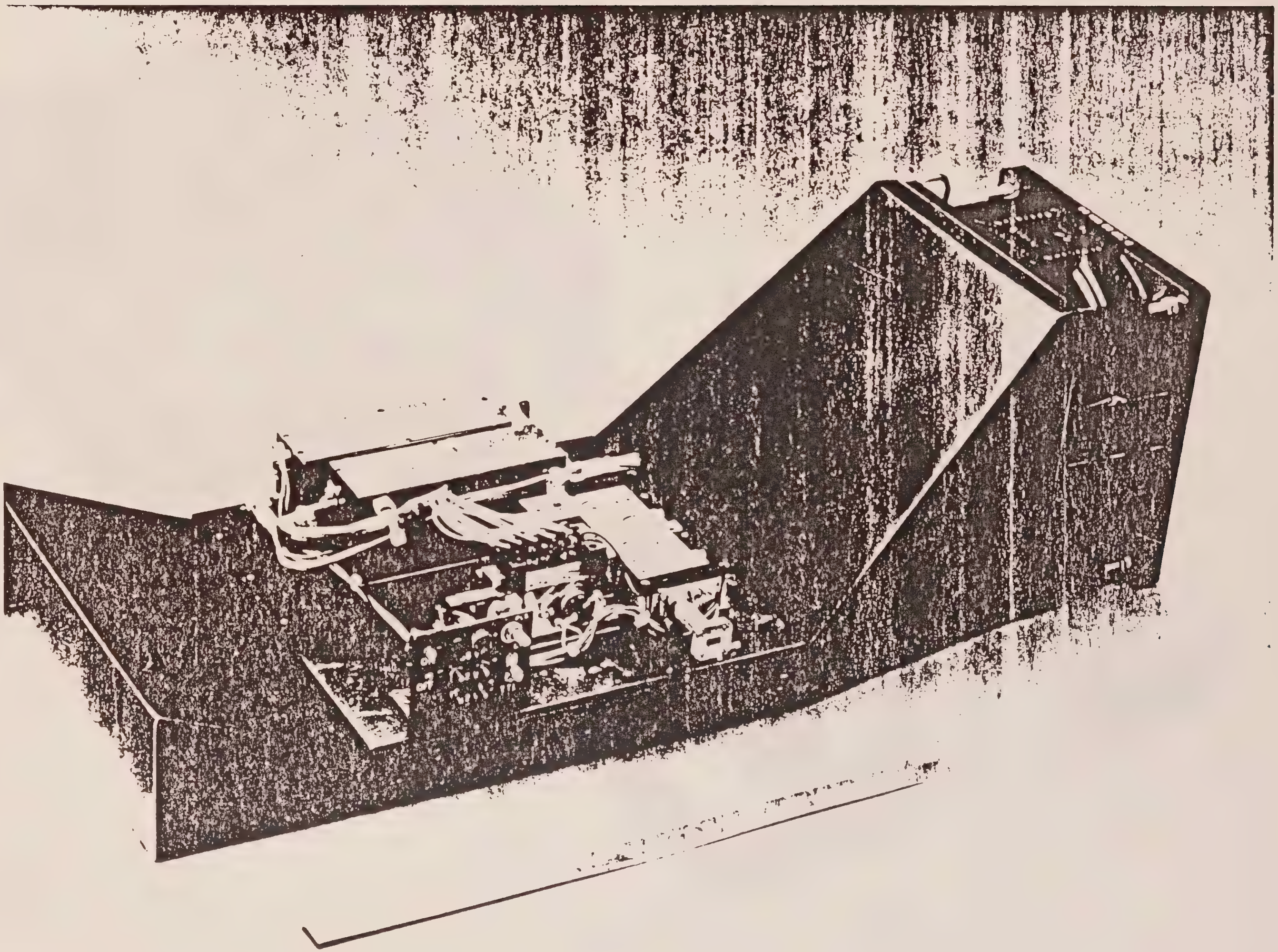
- DEVELOP RECEIVER FOR HBR TDMA
- UTILIZE DESIGNS & TECHNIQUES FOR IMPROVEMENTS IN RELIABILITY, PACKAGING & COST

APPROACH

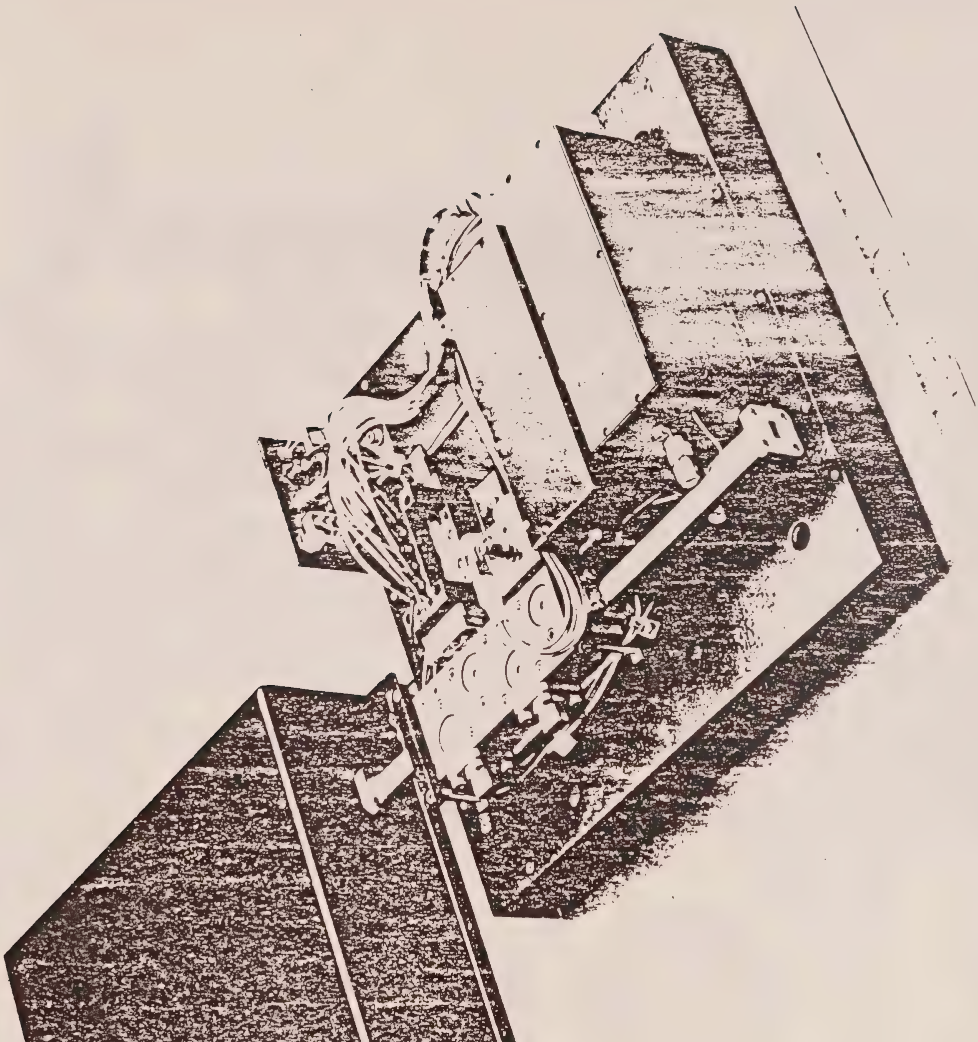
- MAXIMUM MMIC TECHNOLOGY TO BE USED
- ANTENNA MOUNTED DESIGN
- THREE POC MODELS TO BE DELIVERED

- CONTRACT SCHEDULE LENGTH IS 26 MONTHS -- START DATE IS IMMINENT -- HARRIS

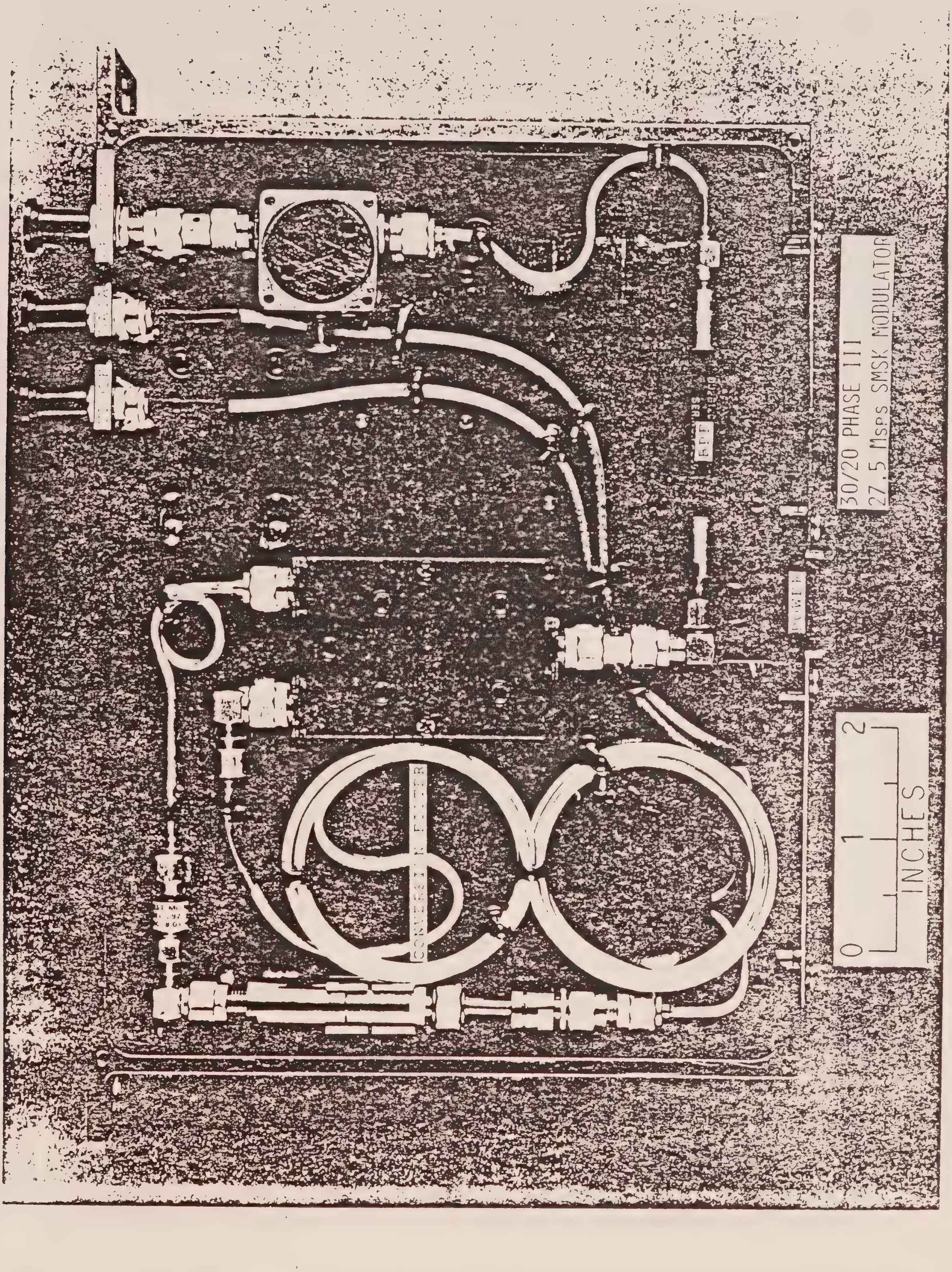
C-85-1814

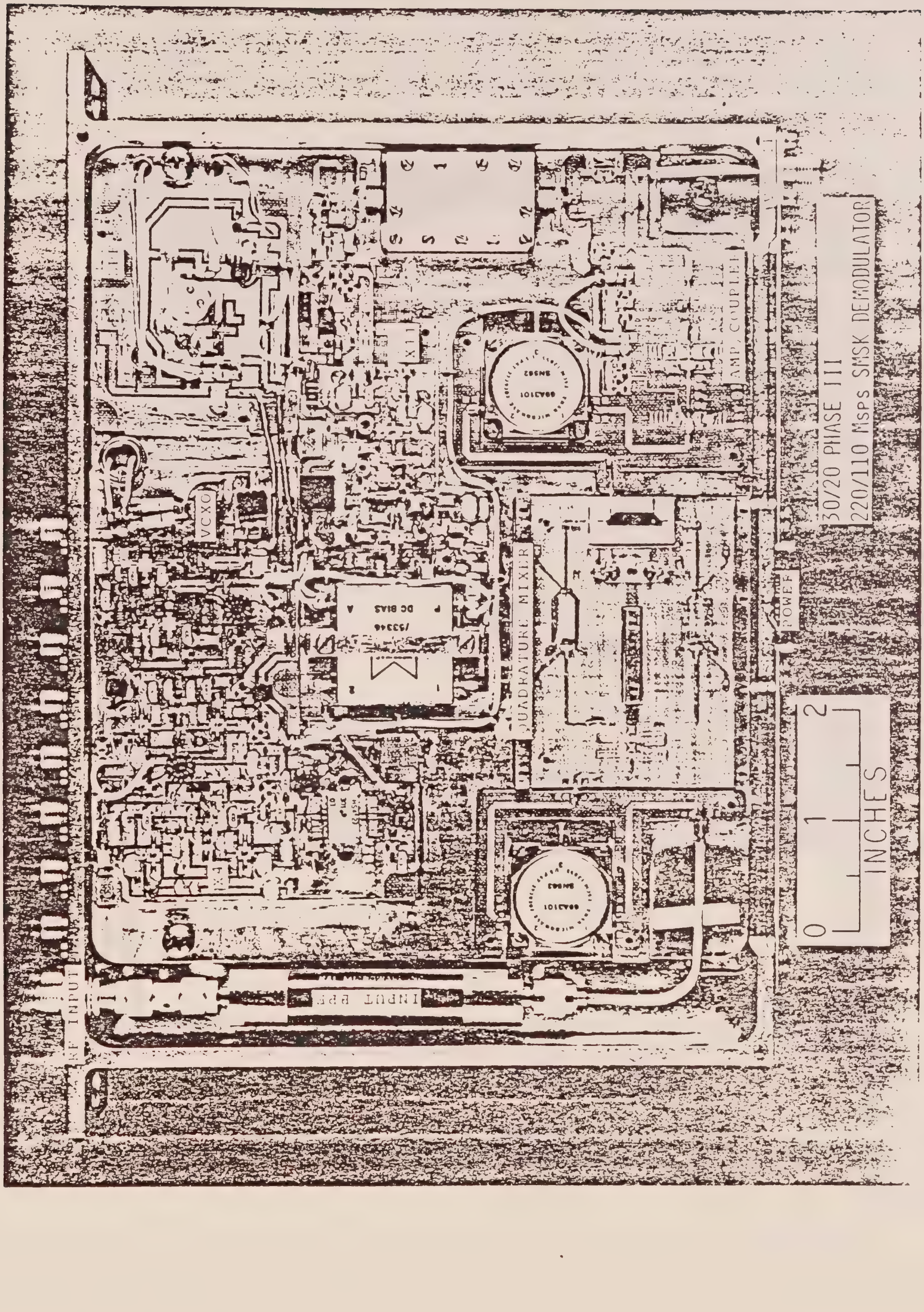


66

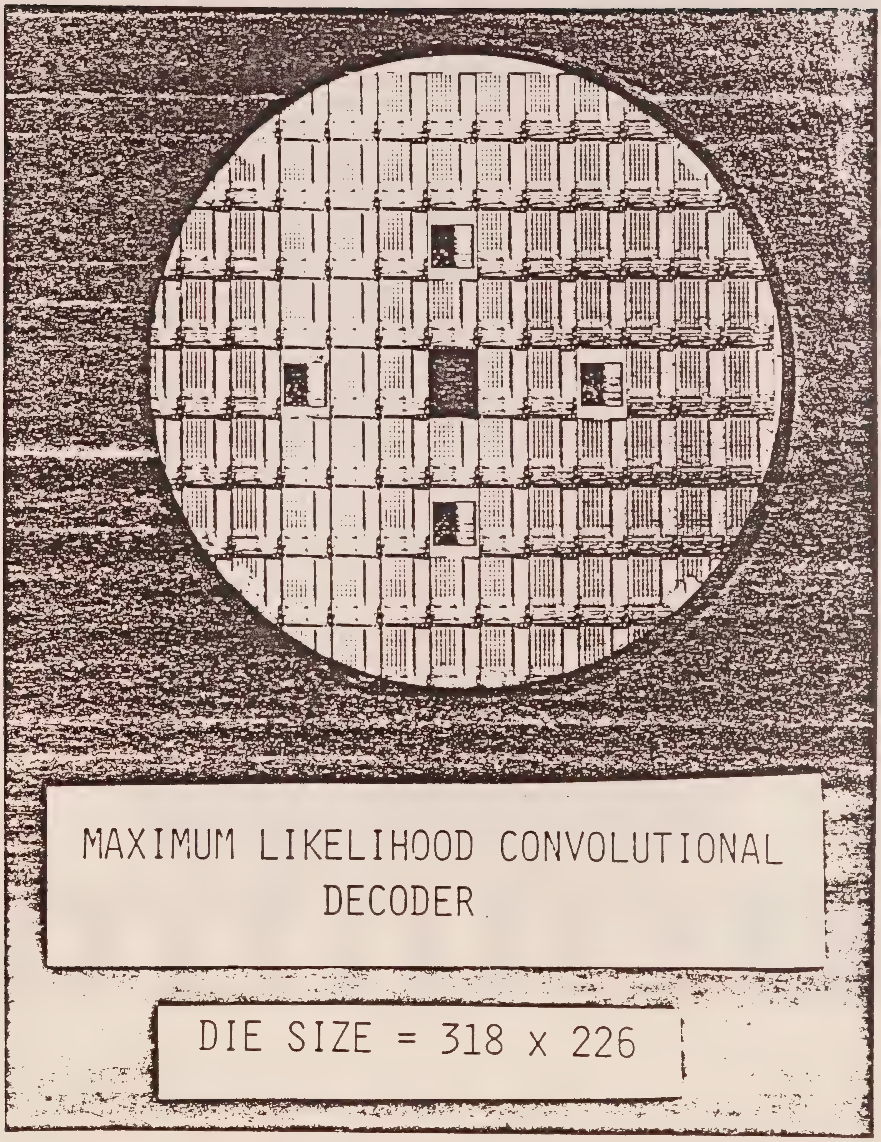


C-85-1813


30/20 PHASE III
27.5 Msps SMSK MODULATOR
0 1 2
INCHES

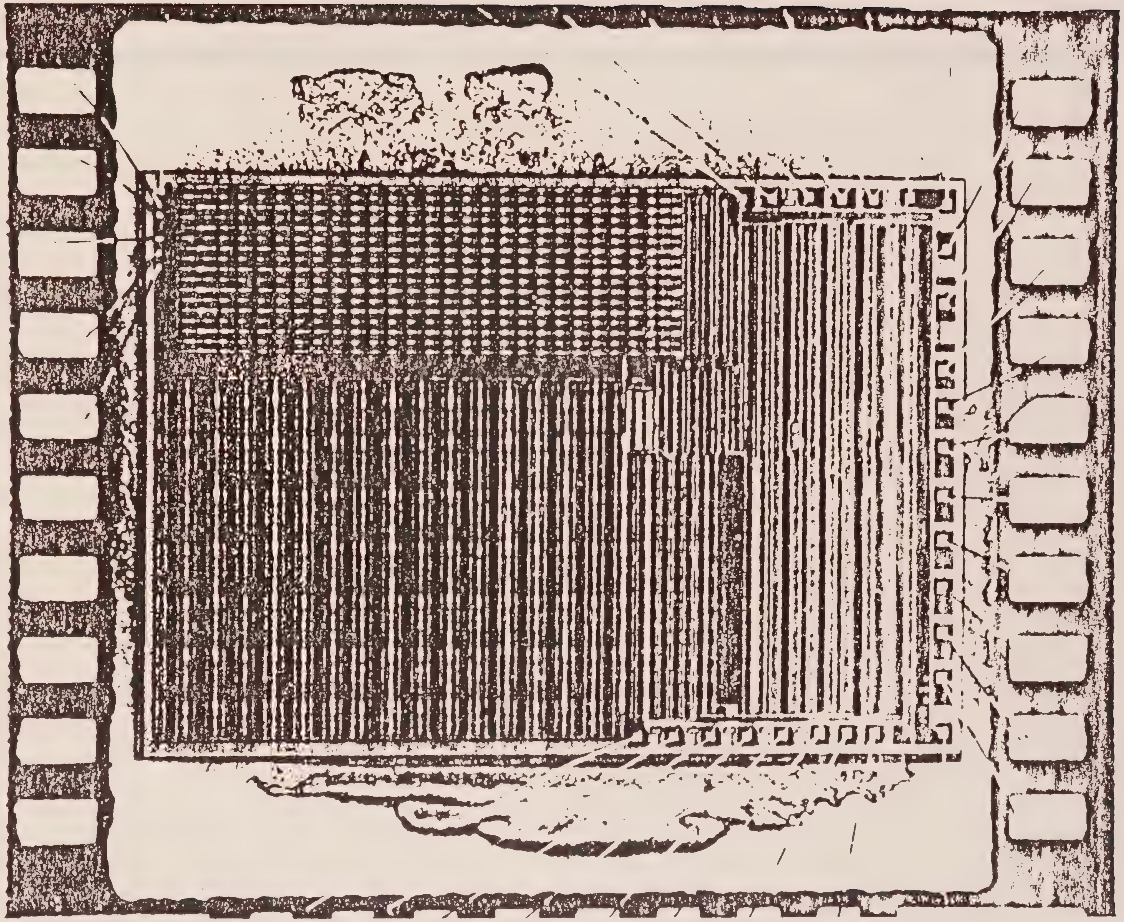

30/20 PHASE III
220/110 Msps SMSK DEMODULATOR
AMP. COUPLER
VCXO
QUADRATURE MIXER
POWER
INPUT BPF
RF INPUT
0
1
2
INCHES

NASA
C-82-6996




MOTOROLA

C-82-6993



PACKAGED FEC DECODER LSI CIRCUIT

MOTOROLA

## GROUND TERMINAL DEVELOPMENTS
## APPLICABLE TO ACTS



1. LeRC IN-HOUSE (LBR 110)

2. ACTS CONTRACT (NGS, HBR & LBR)

3. COMSAT EXPERIMENTER TERMINAL (LBR)

4. RCA EXPERIMENTER TERMINAL (HBR & LBR)

# 110 MSPS BURST RATE IN-HOUSE TERMINAL PROGRAM

OBJECTIVES

- BY CY85 DESIGN, FABRICATE AND TEST COMPLETE TERMINAL. OPERATE IN CY86 WITH NASA LeRC IN-HOUSE BENCH-TEST COMMUNICATION SYSTEM (PRE-ACTS DESIGN)
- MODIFY CONFIGURATION TO SERVE AS ACTS EXPERIMENTER TERMINAL

APPROACH

- ALL COMPONENTS DEVELOPED IN INDUSTRY
- SYSTEMS DESIGN AND INTEGRATION DONE BY LeRC

NASA
C-82-4995




74

# THE ACTS GROUND TERMINALS

## - POTENTIAL FAMILY MEMBERS -

| TYPE | THROUGHPUT (MBS) | UPLINK BURST RATE (MBPS) | ACCESS METHOD | ANTENNA DIA (M) | ESTIMATED QUANTITY SELLING PRICE (FY83 $K) |
|---|---|---|---|---|---|
| HBR | 1 CH @ 220 | 220 | TDMA (IF SWITCH) | 5 | NOT STUDIED |
| LBR (110) | 1 CH @ 110 | 110 | TDMA (BBP) | 5 | NOT STUDIED |
| LBR (27.5) | 1 CH @ 27.5 | 27.5 | TDMA (BBP) | 3 | 200(3) |
| LBR (.056) | 1 CH @ .056 | .056 (CONTINUOUS) | FDMA (IF SWITCH) | 1.5 | 50(4) |

OTHERS -- TBD BASED ON EXPERIMENTERS (CONTINUOUS) INPUTS

1. NON-RECURRING COSTS & INSTALLATION ARE NOT INCLUDED
2. USER INTERFACE IS INCLUDED
3. REFERENCE TRW STUDY NAS3-23341
4. REFEPENCE TRW STUDY NAS3-22889

75

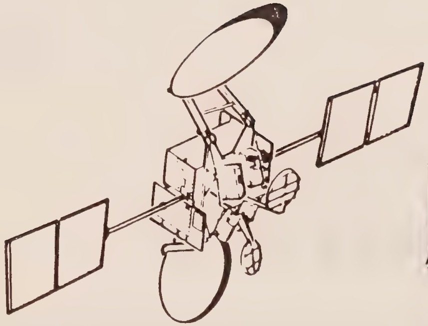
# COMMENTS ON TERMINAL COST STUDIES

1. ESTIMATED QUANTITY SELLING PRICES ARE BASED ON 1982 VINTAGE STUDIES WITH ASSUMPTIONS (QUANTITIES, NON-RECURRING COSTS) THAT MAY NOT FIT ACTS CIRCUMSTANCES

2. ACTS TERMINAL COSTS CURRENTLY APPEAR TO EXCEED QUANTITY PRICES BY AN UNDETERMINED AMOUNT

3. NASA IS RESUMING EFFORTS ON THE TERMINAL COST ISSUE BY FORMULATING A PROGRAM

4. NASA WILL RELY ON SIGNIFICANT INDUSTRY COST SHARING CONTRIBUTIONS IN EXECUTING THE PROGRAM



NASA

ACTS

# ADVANCED COMMUNICATIONS TECHNOLOGY SATELLITE

## EXPERIMENTS PROGRAM

# ACTS EXPERIMENTS PROGRAM

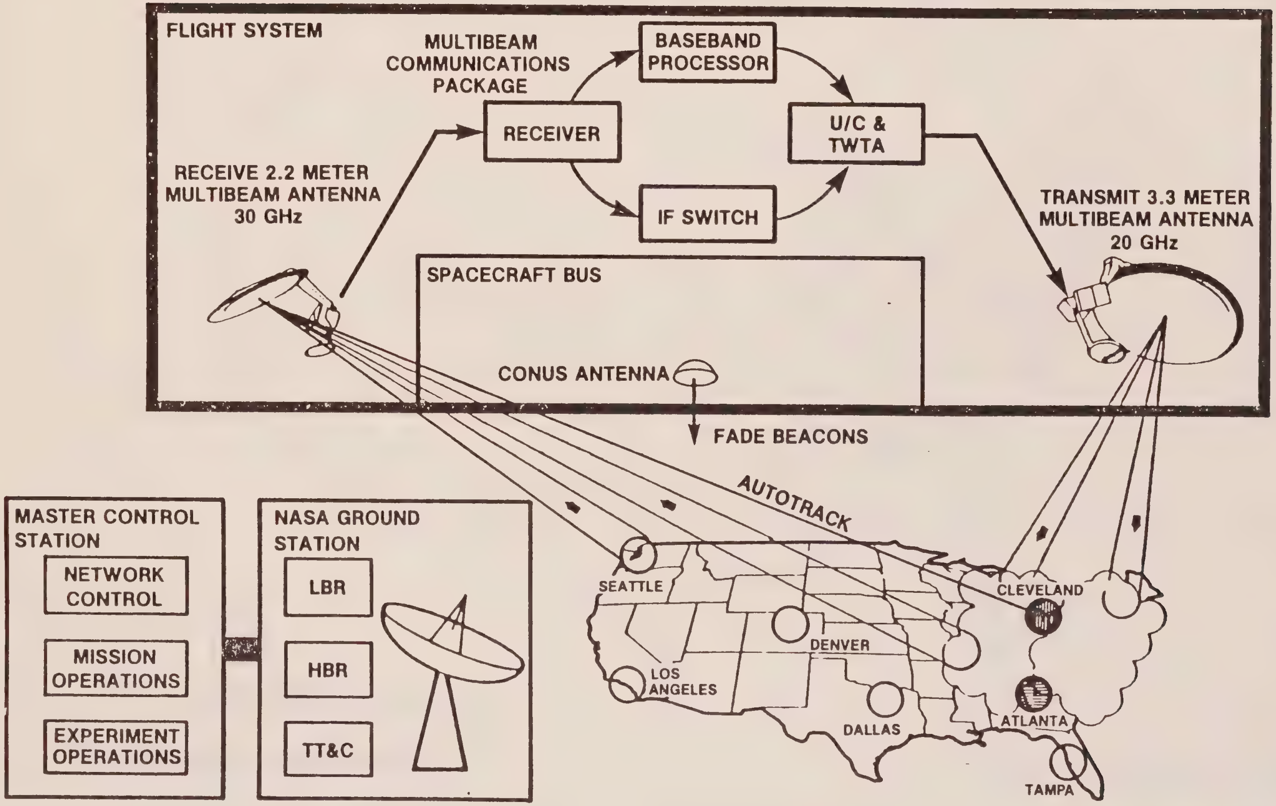
A MAJOR GOAL OF THE ACTS PROGRAM IS TO MAKE AVAILABLE TO PUBLIC AND PRIVATE SECTORS (INDUSTRY, UNIVERSITIES, AND GOVERNMENT) THE CAPABILITIES OF THE ACTS SPACECRAFT FOR EXPERIMENTATION WHICH

- VERIFIES THE TECHNOLOGY
- ASSISTS INDUSTRY IN PLANNING FUTURE SYSTEMS
- AIDS IN MAINTAINING U.S. PREEMINENCE IN SATELLITE COMMUNICATIONS

NASA
C-85-1532

ACTS ADVANCED COMMUNICATIONS TECHNOLOGY SATELLITE

# SYSTEMS OVERVIEW




79

NASA
C-85-1972

NASA

ACTS ADVANCED COMMUNICATIONS TECHNOLOGY SATELLITE

# PRELIMINARY ACTS ANTENNA COVERAGE*

FIXED BEAM

ISOLATED SCANNING BEAM

SCANNING BEAM SECTOR

*BASED ON EXPERIMENTER INPUTS

# ACTS EXPERIMENTS PROGRAM

NASA PROVIDES:

- SPACECRAFT TIME DURING 2 YEAR EXPERIMENT PERIOD
- MASTER CONTROL STATION OPERATIONS
- EXPERIMENT PROGRAM MANAGEMENT
- NASA GROUND STATION FOR EXPERIMENTER USE
- DATA MEASUREMENTS ABOARD SPACECRAFT AND AT MASTER CONTROL STATION

NASA WILL ASSIST EXPERIMENTERS IN:

- EXPERIMENTS PLANNING
- PURCHASING AND/OR LEASING TERMINALS
- UTILIZING NASA GROUND STATION OR OTHER ORGANIZATION'S GROUND TERMINALS

EXPERIMENTER PROVIDES:

- EXPERIMENT PLAN
- RESOURCES TO CONDUCT EXPERIMENT
- EXPERIMENTER WORKING GROUP SUPPORT
- EXPERIMENT OPERATIONS
- ANALYSIS OF EXPERIMENT RESULTS

NASA
C-84-7459

NASA

ACTS ADVANCED COMMUNICATIONS TECHNOLOGY SATELLITE

# ACTS EXPERIMENT EXAMPLES

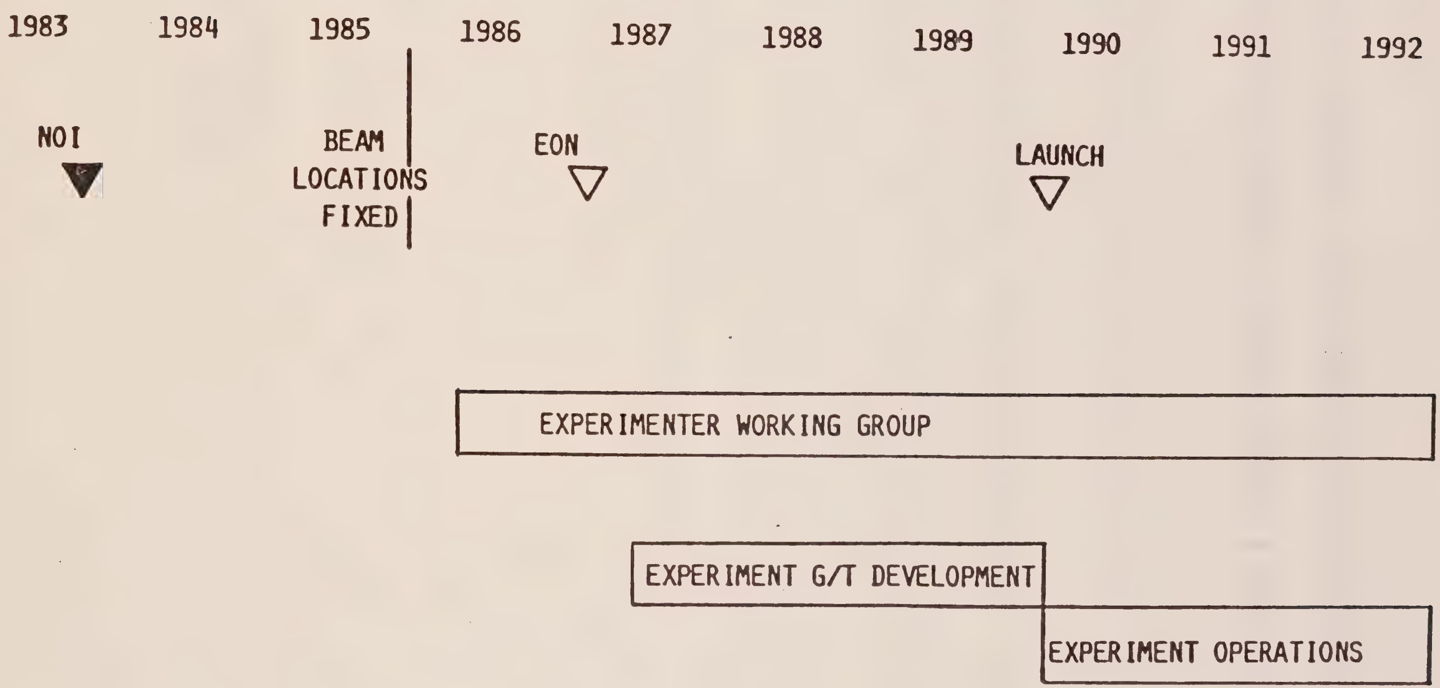
1. FLIGHT SYSTEM TECHNOLOGY EXPERIMENTS
2. GROUND SYSTEM TECHNOLOGY EXPERIMENTS
3. NETWORK CONTROL
4. ACQUISITION, TRACKING AND SYNCHRONIZATION
5. TRANSMISSION IMPAIRMENTS
6. ENHANCEMENT OF LINK AVAILABILITY/RAIN COMPENSATION TECHNIQUES
7. PROPAGATION EXPERIMENTS
8. END-TO-END SYSTEM EXPERIMENTS
9. PROPRIETARY

82

NASA

ACTS ADVANCED COMMUNICATIONS TECHNOLOGY SATELLITE

# ACTS EXPERIMENTS PROGRAM




NOI NOTICE OF INTENT
EON EXPERIMENT OPPORTUNITY NOTICE

# Advanced Communications Technology Satellite (ACTS)

NOTICE OF INTENT FOR EXPERIMENTS

---

Communications Division
Office of Space Science and Applications
NASA Headquarters
Washington, D.C. 20546

March 1983

REVISED NOVEMBER 1984

NASA
National Aeronautics and
Space Administration

## ACTS EXPERIMENT DEVELOPMENT TEAM

| | |
|---|---|
| NASA | D. BRANDEL, NASA HQ<br>W. KONDIK, NASA HQ<br>R. SCHERTLER, NASA LeRC |
| RCA | R. MAEHL<br>C. WHITE |
| TRW | H. BRAHAM<br>D. VRIDRINE |
| COMSAT | C. DEVIEUX, JR. |
| MOTOROLA | B. HOLMES |
| PSSC | L. BRANSFORD<br>M. CLARK |
| ANALEX | P. DONOUGHE |

## EXPERIMENTER WORKING GROUP

- o COMPOSED OF ALL EXPERIMENTERS
- o PLANS AND COORDINATES CONDUCT OF EXPERIMENTS
- o DETERMINES NETWORKS, AND ALLOCATION OF ACTS SYSTEM RESOURCES
- o FOSTERS THE FORMATION OF EXPERIMENT TEAMS

# ACTS EXPERIMENTS PROGRAM

SUMMARY OF NOI RESPONSES:

- o 49 ORGANIZATIONS RESPONDED:
  - 25 PRIVATE COMPANIES
  - 8 UNIVERSITIES
  - 2 DEPARTMENT OF DEFENSE
  - 5 FEDERAL GOVERNMENT
  - 4 NASA CENTERS
  - 5 PUBLIC SERVICE
- o 82 EXPERIMENTS
- o ORIGINAL NOI RESPONSES (NOVEMBER 1983): 31 ORGANIZATIONS
- o ADDITIONAL NOI RESPONSES (MARCH 1985): 18 ORGANIZATIONS

NASA

ACTS ADVANCED COMMUNICATIONS TECHNOLOGY SATELLITE

## ACTS EXPERIMENTS PROGRAM
## SUMMARY OF NOI RESPONSES

MARCH 1, 1985

| | ORGANIZATION | EXPERIMENT(S) |
|---|---|---|
| 1. | COMSAT | PROPAGATION, BUSINESS SERVICES, DEMAND ASSIGNMENT |
| 2. | RCA | LBR AND HBR EVALUATION, TRANSMISSION PARAMETERS |
| 3. | MOTOROLA | BBP/LBR PERFORMANCE |
| 4. | TRW | SYNCHRONIZATION, RECEIVER TECHNOLOGY |
| 5. | GTE | PROPAGATION |
| 6. | SBS | BUSINESS SERVICES, TECHNOLOGY AND DEMONSTRATIONS |
| 7. | AMERICAN SATELLITE | TELECOMMUNICATION TECHNOLOGY AND SERVICES |
| 8. | SPACECOM | TELECOMMUNICATION TECHNOLOGY AND SERVICES |
| 9. | GTE-SPACENET | TELECOMMUNICATION TECHNOLOGY AND SERVICES |
| 10. | BONNEVILLE COMMUNICATIONS | TELECOMMUNICATIONS SERVICES |
| 11. | SCIENTIFIC-ATLANTA | G/T ANTENNA TRACKING |
| 12. | ANDREW | ANTENNA TECHNOLOGY |
| 13. | M/A-COM | G/T TECHNOLOGY |
| 14. | LNR | G/T TECHNOLOGY |
| 15. | COMSAT TECHNOLOGY PRODUCTS | G/T TECHNOLOGY |
| 16. | COLORADO VIDEO | TECHNOLOGY |
| 17. | COMTECH MW | G/T TECHNOLOGY |

55

NASA

ACTS ADVANCED COMMUNICATIONS TECHNOLOGY SATELLITE

## ACTS EXPERIMENTS PROGRAM
## SUMMARY OF NOI RESPONSES (CONT'D)

MARCH 1, 1985

| | ORGANIZATION | EXPERIMENT(S) |
|---|---|---|
| 18. | ORI | POWER CONTROL, RAIN INTERFERENCE |
| 19. | E-SYSTEMS | ELECTRONIC MAIL |
| 20. | NASA AMES | DATA TRANSFER/ADVANCED VIDEOCONFERENCING |
| 21. | NASA LEWIS | FLIGHT & GROUND TECHNOLOGY, NETWORK, SYNCH. |
| 22. | NASA HQ - EARTH SCI & APPL DIV | DATA TRANSFER BETWEEN LARGE DATA BASES |
| 23. | JPL | PROPAGATION |
| 24. | DEPARTMENT OF DEFENSE | VOICE, VIDEO & DATA TRANSFER |
| 25. | NCS | TELECOMMUNICATION SERVICES |
| 26. | GSA | BUSINESS SERVICES |
| 27. | NTIA | SYNCHRONIZATION |
| 28. | DOT | TELECONFERENCING |
| 29. | VPI & SU | RAIN ATTENUATION, PROPAGATION |
| 30. | OHIO STATE UNIVERSITY | TRANSMISSION IMPAIRMENTS, SITE DIVERSITY |
| 31. | JOHNS HOPKINS/U OF TEXAS | PROPAGATION, TRANSMISSION IMPAIRMENTS |
| 32. | UNIVERSITY OF MIAMI | RAIN ATTENUATION |
| 33. | SOUTHERN ILLINOIS UNIVERSITY | TELECONFERENCING |
| 34. | TENNESSEE STATE UNIVERSITY | PROPAGATION MEASUREMENTS |

ACTS EXPERIMENTS PROGRAM
SUMMARY OF NOI RESPONSES

MARCH 1, 1985

| | ORGANIZATION | EXPERIMENT(S) |
|---|---|---|
| 35. | CREIGHTON UNIVERSITY | TELECOMMUNICATIONS SERVICE APPLICATIONS |
| 36. | STEVENS INSTITUTE OF TECHNOLOGY | TECHNOLOGY |
| 37. | SCIENCE APPLIC., INC. | PROPAGATION STUDIES |
| 38. | AZ TECH INC. | SATELLITE DATA DISTRIBUTION |
| 39. | PARTNERSHIP FOR PRODUCTIVITY | LOW COST G/T DEVELOPMENT |
| 40. | RESEARCH HEALTH SERVICES | MEDICAL TELECOMMUNICATIONS |
| 41. | ALTERNATE SYS. LAB. | TELECOMMUNICATIONS PLANNING |
| 42. | AMERICAN ASSOCIATION OF HIGHER ED. | TELECOMMUNICATION SERVICES |
| 43. | NATIONAL FIRE PROTECTION ASSOC. | TELECOMMUNICATION SERVICES |
| 44. | U. S. CONFERENCE OF MAYORS | TELECOMMUNICATION SERVICES |
| 45. | VOLUNTARY HOSPITALS OF AMERICA | TELECOMMUNICATION SERVICES |
| 46. | AMERICAN MEDICAL ASSOCIATION | TELECOMMUNICATION SERVICES |
| 47. | LOCKHEED | ENVIRONMENTAL MONITORING |
| 48. | NBS | ORBITING STANDARDS PACKAGE |
| 49. | LINCOLN LABS | LASER PACKAGE |

NASA

ACTS ADVANCED COMMUNICATIONS TECHNOLOGY SATELLITE

## FOR MORE INFORMATION ON ACTS CONTACT:

- RONALD J. SCHERTLER
  ACTS PROJECT EXPERIMENTS MANAGER
  NASA LEWIS RESEARCH CENTER
  MAIL STOP 54-6
  21000 BROOKPARK ROAD
  CLEVELAND, OHIO 44135
  (216) 433-4000 EXT. 792

- DANIEL L. BRANDEL
  ACTS PROGRAM MANAGER
  CODE EC-4
  NASA HEADQUARTERS
  WASHINGTON, D.C. 20546
  (202) 453-1505

- WILLIAM T. KONDIK
  ACTS DEPUTY PROGRAM MANAGER
  CODE EC-4
  NASA HEADQUARTERS
  WASHINGTON, D.C. 20546
  (202) 453-1505

- CHRISTOPHER WHITE
  RCA ASTRO-ELECTRONIC
  MS TR6-C
  P.O. BOX 800
  PRINCETON, NJ 08540
  (609) 426-3077

- LOUIS A. BRANSFORD
  PUBLIC SERVICE SATELLITE CONSORTIUM
  SUITE 907
  1660 L STREET, NW
  WASHINGTON, D.C. 20036
  (202) 331-1154

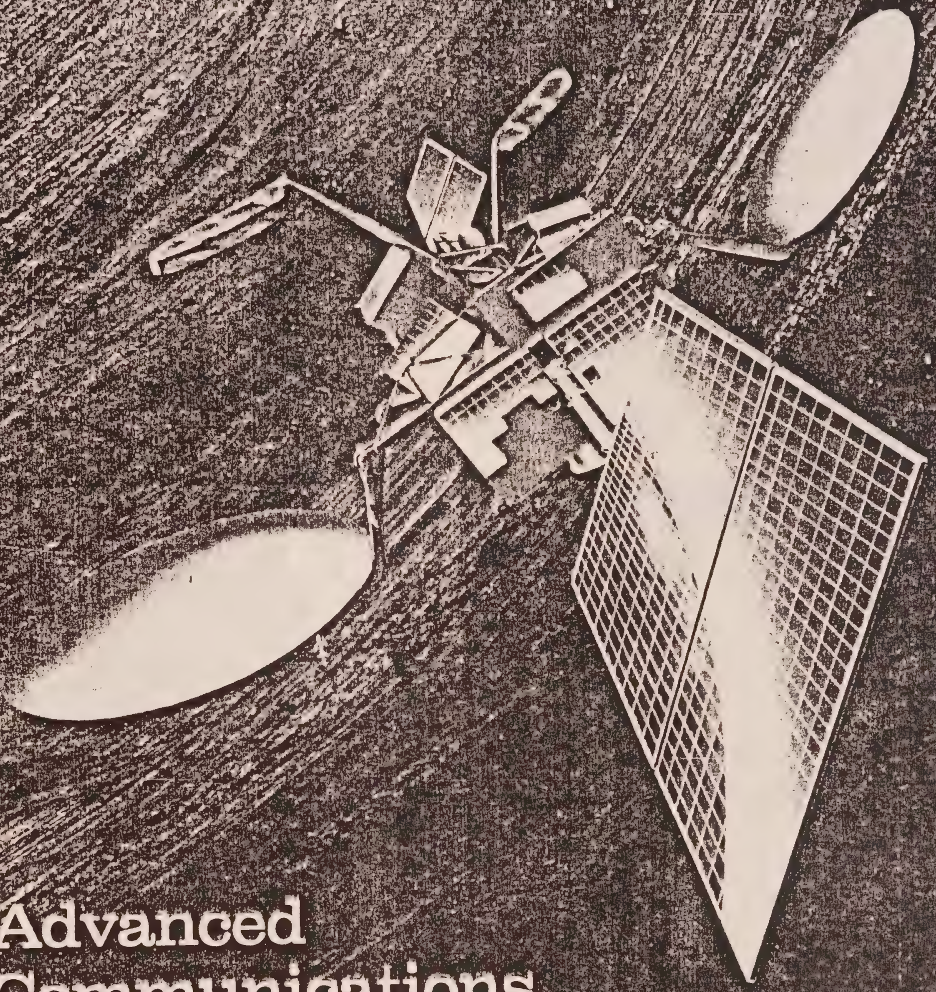
- CARRIE DEVIEUX, JR.
  COMSAT GENERAL CORPORATION
  950 L 'ENFANT PLAZA, SW
  WASHINGTON, D.C. 20024
  (202) 863-7416

- HAROLD S. BRAHAM
  TRW
  MS-2486
  ONE SPACE PARK
  REDONDO BEACH, CA 90278
  (213) 535-3196

- A. BOYD HOLMES
  MOTOROLA INC
  M.S. 2243
  8201 W. McDOWELL ROAD
  SCOTTSDALE, AZ 85252
  (602) 949-3965

1

# ACTS



## Advanced Communications Technology Satellite Program

# History

## North American Domsats in Geostationary Orbit

(January 1984)

Following the opening of the space age by the Soviet Union's Sputnik satellite in 1957, NASA became a prime mover in a series of experimental space communications projects in the early 1960's—Echo, Relay, Telstar, Syncom II, etc. Out of this work came the spacecraft and Earth station technologies that make today's satellite communications possible. After the successful demonstration of Syncom II, the privately owned Communications Satellite Corporation (Comsat) was created by Congress and given the mandate embodied in the Communications Satellite Act of 1962: to establish a global commercial communications satellite system in conjunction and cooperation with other countries via the Intelsat organization. When the first Intelsat became operational in 1965, only five countries had access to the satellite; today over 150 countries are full-time users of global satellite services.

The success of Intelsat in providing cost effective communications services and the continuing advances in technology gave impetus to the U.S. domestic satellite (Domsat) industry. Since the launching of Westar 1 in 1974, 22 U.S. Domsats have been put into operation, and their number is growing rapidly. As of January 1984 applications before the FCC contain requests for permission to launch more than 60 additional C-band and Ku-band satellites, although the limited geostationary arc above the U.S. will not support such a large number. This rapid industry growth and the requests for additional satellites are based on an ever expanding demand for voice, data, and video communications services supplied from space.

NASA's role in satellite communications remained in high gear through the middle 1960's and early 1970's. Six Applications Technology Satellites (ATS) and one Communications Technology Satellite were developed and launched. These demonstrated several innovations, including communications to mobile receivers and TV broadcasting to small portable Earth terminals. In 1973 the NASA program in satellite communications technology was phased down considerably, based on the belief that the private sector would carry on future development. The communications industry did, indeed, make noteworthy advances: the number

| 1957 | 1960 | 1962 | 1963 | 1965 | 1966 |
|---|---|---|---|---|---|
| Sputnik<br>Opening of the space age | Echo, Relay, Telstar<br>NASA becomes prime mover in space communications<br>Syncom II Geostationary orbit explored for satellite communications | Communications Satellite Act passed | Comsat formed | Early Bird.<br>North Atlantic Commercial Satellite Service by Intelsat | Anik, Satcom, Comstar, Westar, Intelsat<br>Canadian and U.S. Domsat market opened |

of circuits per satellite was increased, satellite weight per circuit was decreased, antenna design was improved, frequency reuse was achieved through cross polarization, and demand-assignable access and time-division multiple access to a satellite were achieved. As noteworthy as these advances are, they were undertaken by industry because they offered (1) a modest risk for the cost, (2) a relatively near-term market payoff, and (3) affordable development costs. The private sector's ability to fund long-term, high-risk, and high-cost satellite communications research is limited.

While the U.S. satellite communications R&D program slowed between 1973 and 1979, the Japanese and European efforts accelerated. The Japanese already have launched communications satellites for tests and operation in the C-, Ku-, and Ka-bands. Although the first satellites in these programs were bought from U.S. industry, all subsequent models will be made in Japan. It is also noteworthy that the Japanese have become the leading supplier of Intelsat Earth stations and are likely to take the world market lead in the sale of television systems designed specifically for direct-broadcast satellite reception. The efforts by the Japanese and similar activities in Europe, particularly in the areas of spot-beam technology and Ka-band advances, are serious threats to the U.S. lead in satellite technology, systems, and market share. It has become clear that without appropriate government support, the U.S. satellite lead will be lost, following the unfortunate precedent established in the consumer electronics industry.

## THE GROWING LIST OF NEW U.S. SATELLITE OWNERS

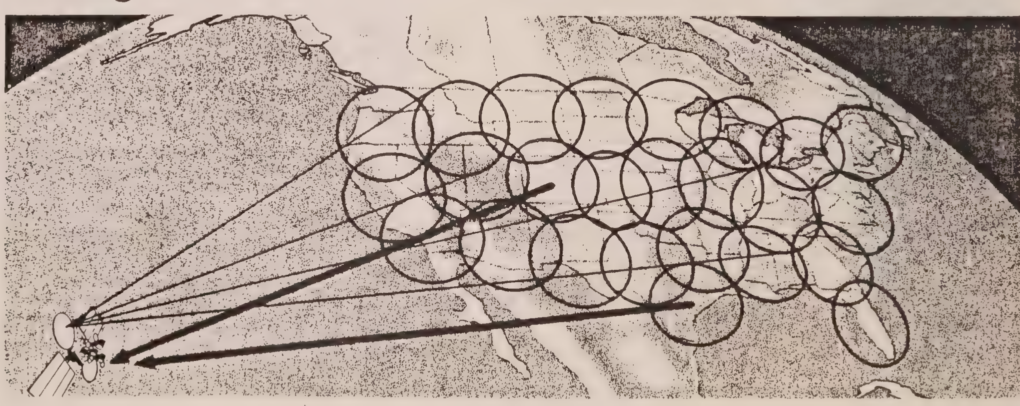
| 1970–1979 | 1980–1985 | 1986–1990 |
|---|---|---|
| Comsat | American Satellite | Advanced Business Communications |
| RCA | AT&T | Columbia Communications |
| Western Union | GTE | Digital Telesat |
| | Hughes | Equatorial Communications |
| | Satellite Business Systems | Federal Express |
| | | Ford |
| | | Martin Marietta |
| | | National Exchange |
| | | Rainbow |
| | | Systematics General |
| | | U.S. Satellite Systems |

| | 1972 | 1973 | 1974 | 1976 | 1977 | 1980 | 1983 |
|---|---|---|---|---|---|---|---|
| Expansion of Intelsat to global coverage | Canadian Anik I<br>Domestic service (C band) | NASA satellite communications program phased down | Westar I<br>U.S. Domestic service (C band) | CTS Ku band experiments<br>Commercial exploitation | Japanese CS–1<br>Ka-band experiments | SBS<br>U.S.<br>Domestic service (Ku band) | Japanese CS–2<br>Domestic service (Ka band) |

# Tomorrow's Technology Needs

The factors leading to NASA's reentry into satellite communications R&D are multifaceted and interrelated. Of importance is the fact that worldwide competition has already begun to erode the U.S. lead in satellite technology. But of foremost significance is the recognition that the present rapid growth of domestic voice, data, and video traffic addressable by satellites will exceed the capacity of conventional C- and Ku-band satellites within a decade. Continued growth of satellite-supplied domestic services and their accompanying benefits can only be achieved if additional capacity can be drawn from our geostationary arc and allocated satellite frequencies. Such capacity increases must be accomplished by more effective use of the C and Ku bands and by use of other frequency bands, such as the Ka band—the next higher band allocated for satellite communications. Utilization of all frequency bands could be enhanced through the principle of multibeam frequency reuse. Unlike today's conventional satellites, which cover the continental United States (CONUS) with a single, stationary antenna coverage pattern, advanced antenna technology could enable future satellites to concentrate communications capacity into narrow spot beams. Each beam would provide coverage over a spot only a few hundred miles in diameter, and the spacing of these spots across the country would allow use of the same frequency in many beams, hence, frequency reuse. Further technology advances could enable, not only fixed spot beams, but also beams that would be scanned across the country, with the capacity of the beam divided according to the demands of users at different locations. By adjusting the time a beam would dwell on any one location, very efficient use could be made of available satellite capacity. Switching on-board the satellite could provide complete interconnection between the beams, either fixed or scanning. Such frequency reuse could expand the capacity of future satellites by a factor of 5 or 10 times that of today's satellites. Commercial implementation of Ka-band through technology advances could also significantly expand available communications satellite capacity. The allocated frequency bandwidth at the Ka-band is over two times larger than the combined bandwidths of the C- and Ku-bands. Multibeam systems and

## Typical Multiple Spot-Beam Coverage Pattern



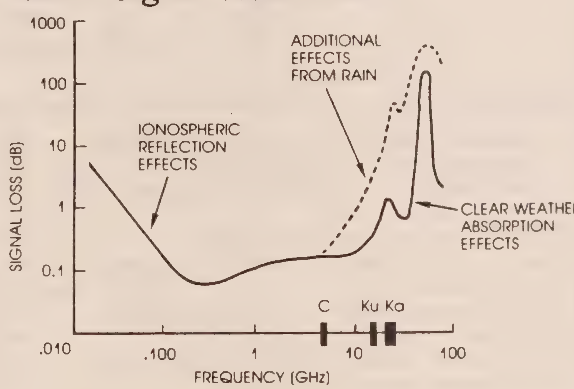
use of Ka-band require new improved satellite technology, and, in addition, the Ka-band is highly susceptible to communications outages caused by rainfall. Although potential technological solutions are available to supply highly spectrum efficient multibeam systems, even at Ka-band, they involve high development risks and attendant long-term development costs that appear to be well beyond the funding ability of private industry. Only through an experimental program can these risks be reduced to acceptable levels and the associated technologies proven commercially viable.

In recognition of these factors various committees, technical societies, and government organizations proposed that NASA resume support of satellite communications R&D. Over 100 private and government entities, representing a wide range of interest in satellite communications, provided inputs to NASA's planning for reentry into the development of satellite communications technology. Official sanction was contained in the 1978 Presidential Directive PD–42, which directed NASA to reassume its responsibility for advanced space communications technology. In cooperation with the National Research Council's Space Applications Board Subcommittee on Satellite Communications, whose membership was composed of leading common carriers, spacecraft manufacturers, and representatives of communications users, the future technology program was planned. The ACTS program was endorsed by this group as the principal element of NASA's reentry into satellite communications R&D.

At the outset a series of assessment studies was undertaken to determine the potential role of advanced communications technology in the U.S. These studies reaffirmed that the ever-increasing demand for communications services would probably saturate existing and planned systems near the end of this decade. To relieve the pressure of this expanding market, not only would provisions for better frequency use (multiple frequency reuse at the lower bands) have to be incorporated, but the new Ka-band would need to be introduced in a similar efficient manner. The technology necessary to accomplish this would provide the added advantage of augmenting existing services through direct satellite communications in the customer's premises using small, low-cost Earth stations. The market studies also identified several services that could be expected to use advanced satellite communications technology: these included wide-band data transmission and digital voice/data networks.

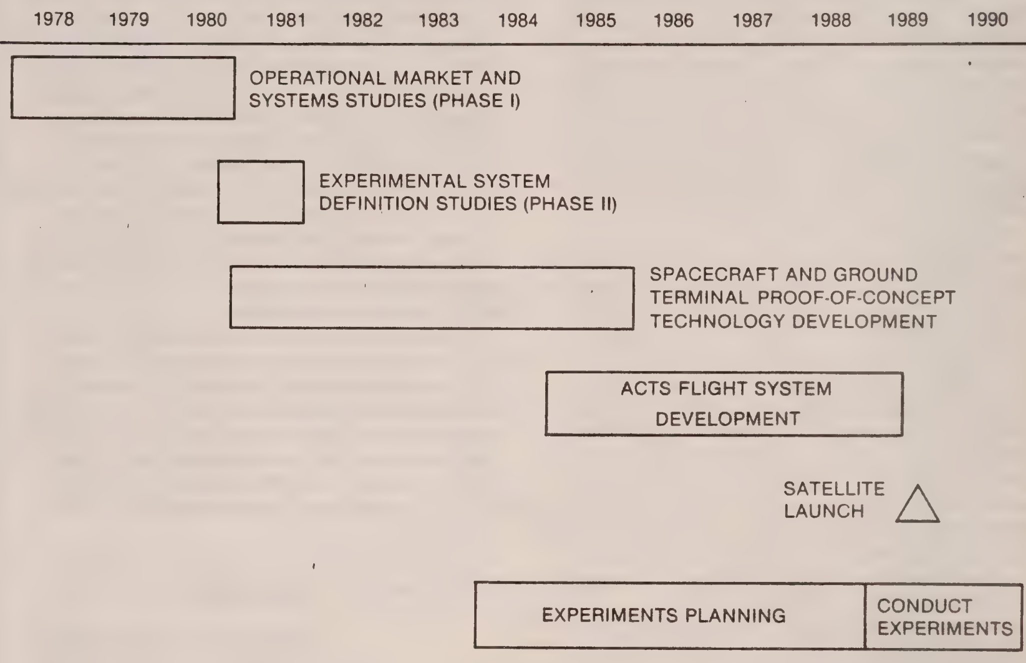
Maintaining the present downward trend in the cost of telecommunications service for the U.S. public is a major incentive for developing and using this technology. But the studies also were unanimous in concluding that an advanced development effort is essential if the United States is to continue to lead the world in satellite communications technology and its application.

## Radio Signal Attenuation



# ACTS Program

## ACTS Program Schedule




NASA's ACTS program is in response to the following needs:

- To provide advanced technology that will help to increase satellite communications capabilities and ensure continued growth in cost effective services
- To verify the technical and economic feasibility of innovations for new and existing frequency bands
- To provide technology that will reduce the technical risk of improving system effectiveness in using the geostationary orbit and allocated frequency spectrum
- To assure that the U.S. can effectively compete in a market threatened by foreign competition

To these ends, the NASA program is structured to

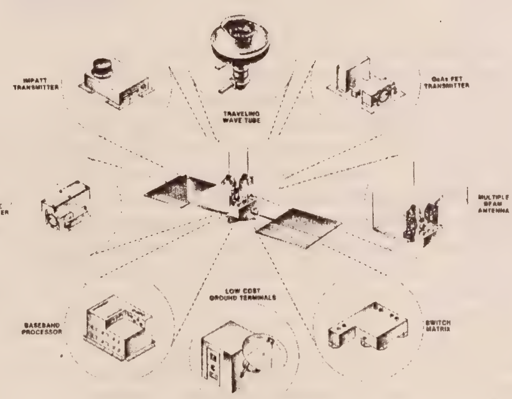
- Establish a government-industry working relationship
- Provide for intensive interaction within industry
- Enable technology transfer
- Maintain U.S. technology lead

The philosophy of the NASA program is to develop those areas of advanced technology that carry a high level of technical risk, to verify the performance of subsystems in the laboratory, to bring the technology to flight readiness, and to verify the technology in experimental use where necessary to enhance industry implementation.

A strong government-industry working relationship has promoted effective interaction between NASA and industry as well as within the industry itself. Following an industry review of the results of the market studies and early system definition studies, a list of critical enabling technologies was identified as being appropriate for NASA-sponsored development. NASA subsequently awarded contracts to various aerospace and related companies for the development of high-risk technologies in the areas of multiple spot-beam satellite antennas, satellite switching and/or processing systems, high-frequency/high-power systems, and low-cost Earth stations for providing direct-to-customer services. The multiple awards were issued to ensure that a variety of perspectives and technical approaches would be brought to each area. These contracts provided for the development of the technologies and construction of proof-of-concept (POC) versions of each. These POC devices have been laboratory tested to verify anticipated performance.

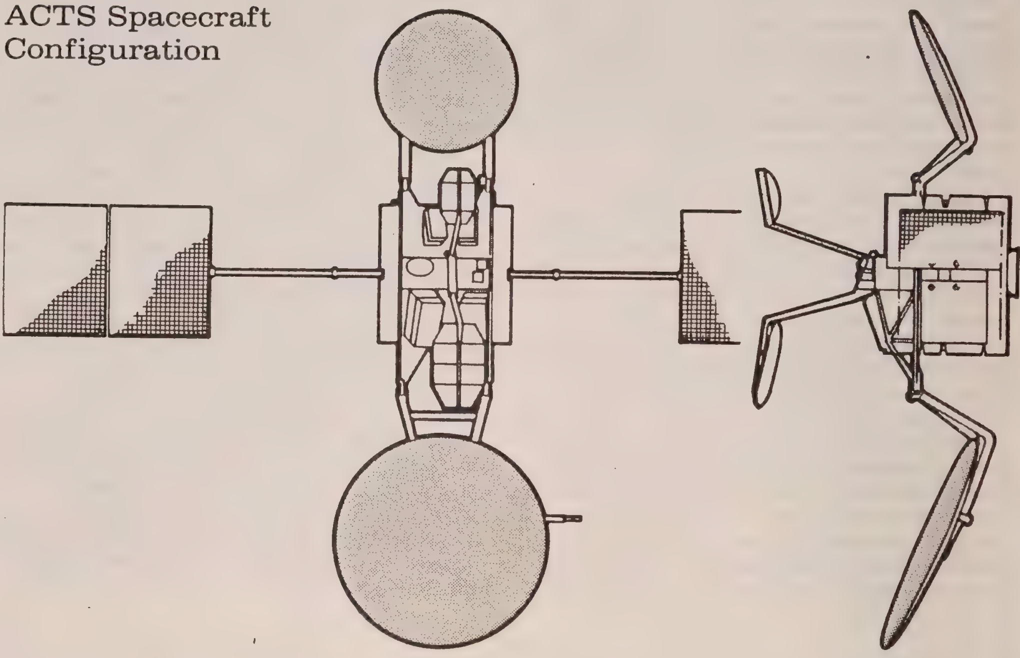
As a final phase in the technology development process, selected technology will be tested in an experimental flight system to be launched in 1989. The goal of the flight system and the experiments to be performed with it is to complete technology development to a level of technical risk acceptable for industry implementation. The experimental system will include only the minimum equipment required to achieve this goal in cooperation with the industry and other Government agencies. Limited communications capability, through far below that of an operational system, will allow testing of the new technologies under realistic conditions. Such tests will ensure that the technology base is mature and validated, providing the level of confidence and experience necessary for commercial application and an expanding industry.

ACTS Development Elements



# ACTS Experimental Flight

## ACTS Spacecraft Configuration

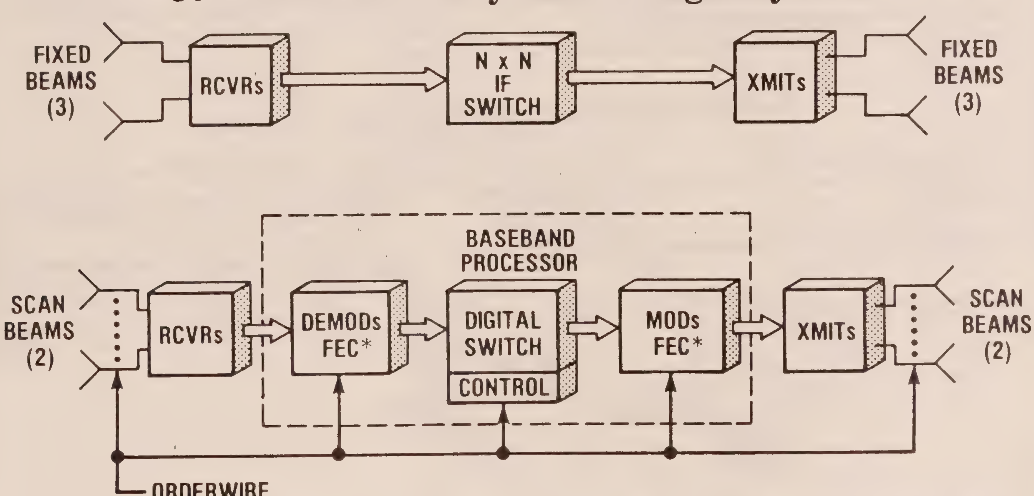


With the scheduled launch of the ACTS experimental satellite in 1988, NASA will have ended a 12-year hiatus in orbiting advanced communications satellite technologies. The flight of ACTS and the tests to be conducted with its experimental systems will represent the final phase of the cooperative NASA-industry program to develop technological advances considered essential to enabling cost effective communications satellites in the 1990's. As in the previous program phases, the flight and experiments will be focused on the development of spot-beam, frequency-reuse technology to enable expanded communications capabilities. As in the proof-of-concept program, these technologies will be developed and tested in the Ka band, a valuable new frequency regime, to further enhance expanded satellite capabilities. The successful proof-of-concept program and a series of advanced systems studies identified the technologies that required further testing on a space flight system. These technologies are critical enabling technologies—i.e., they are essential to the spot-beam frequency reuse concept—whose effectiveness can only be proved through on-orbit experimental satellite tests. The ACTS experimental system is designed to satisfy the final technology development requirement and is centered around a scanning, multibeam antenna and its supporting advanced switching and processing systems.

The key to effective spot-beam frequency reuse and the growth it provides in satellite capacity is the multibeam antenna (MBA). Whether the spots are fixed or scanning, the MBA must be capable of providing highly focused beam patterns to ensure little or no interbeam interference. Use of the Ka band, such as on ACTS, further requires that the MBA provide high antenna gains to overcome the expected fades in signal due to rain. If spot scanning is used, the complexity of the antenna's beamforming components increases, but the efficiency and flexibility of the communications system is greatly enhanced. High-speed scanning of the spot beam allows dynamic coverage to occur in response to fluctuating user demands. Each scanning beam only needs to cover areas that have communications needs at the moment and only needs to dwell there long enough to satisfy those needs. System efficiency can further be enhanced by distributing the capacity resources of the beams (fixed or scanning) and the satellite through an access assignment technique called time-division, multiple access (TDMA). By dividing the satellite communications signals into short, compressed bursts of information, several users may transmit and receive at the same frequencies by taking turns or time sharing. The time slot allocated to a given Earth station can be lengthened or shortened to accommodate a varying amount of communications needs. These TDMA time slots will be adjusted and synchronized by a master control station which oversees the satellite network operations. Use of TDMA is essential to effective utilization of the scanning spot beams.

Use of multiple spot beams requires a switching system on-board the satellite to interconnect the beams and route signals, or

## Communications Payload for Flight System



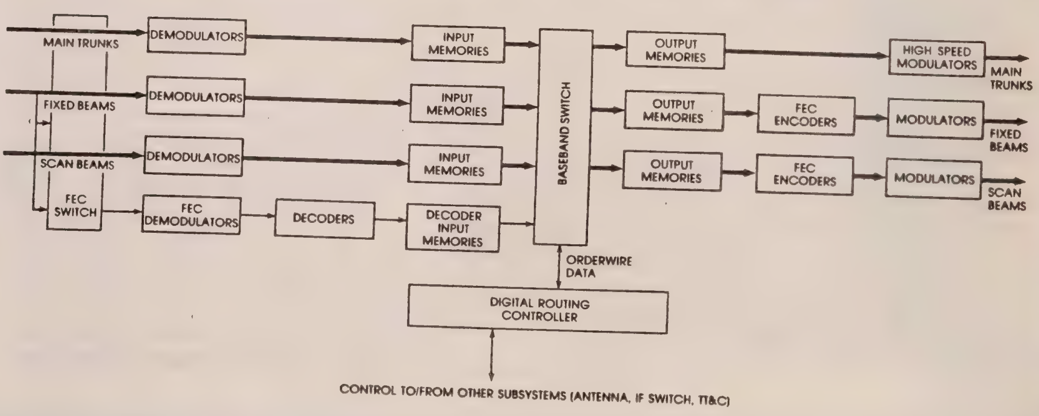

*FEC—FORWARD ERROR CORRECTION

messages, to their appropriate destinations. Two distinct types of switching facilities will be tested on ACTS: Intermediate frequency (IF) matrix switching and baseband processing. The IF matrix switch is used to interconnect the high-volume, wide-bandwidth communications transmitted over fixed beams. High-performance, solid-state switching devices will be required to accommodate high-speed switching between a large number of wide-band inputs and outputs and at the same time provide low crosstalk at all output ports. Dual-control switch memories also will be needed to allow changes in the switching plan without loss of service.

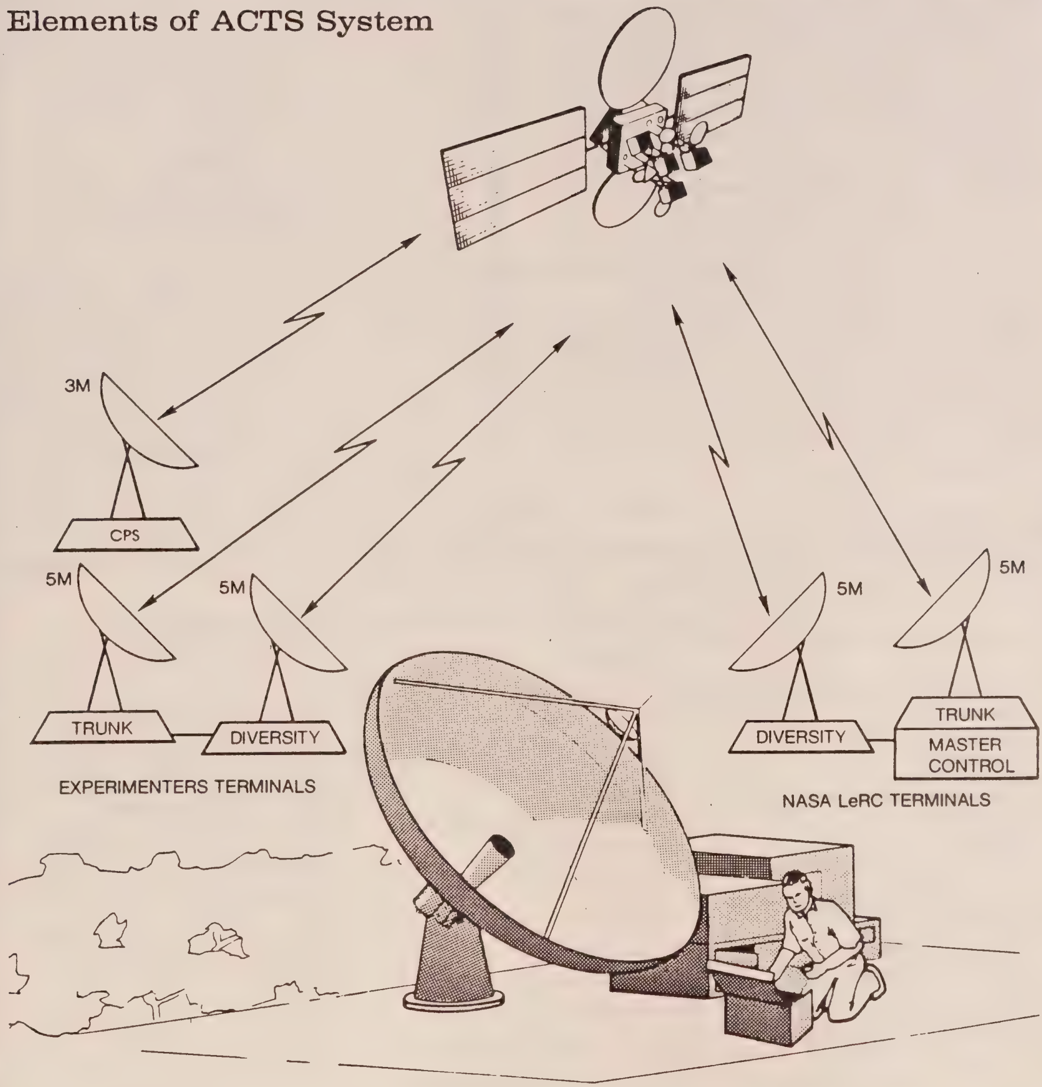
The baseband processor is the heart of the scanning spot-beam system and provides efficient routing of low-volume communications from small Earth terminals, such as those located directly on the customer's premises. The baseband processor reduces the signals received by the satellite down to their baseband content—digital data consisting of binary ones and zeros. These data are then stored and routed to their correct destination. In addition to permitting signal error detection and correction, the baseband processor will provide highly dynamic routing of individual telephone calls and, in essence, move the switchboard from the ground to the sky.

The ACTS experimental flight system is designed to verify each of these critical technologies as well as test their combined effectiveness in a communications satellite system. As a communications system, ACTS represents the minimum level of capability necessary to carry out these tests. The three fixed beams, two scanning beams, IF matrix switch, and baseband processor on ACTS will only supply about a tenth of the communications capacity expected to be achieved by operational satellites of the 1990's. During the flight, NASA will assist experimenters from the public and private sectors to test the performance and capabilities of the ACTS advanced technologies. Results of the flight experiments will provide information vital to successful industry implementation of the ACTS technology in future operational systems.

## Baseband Processor Message Routing



## Elements of ACTS System



# Outlook

The geosynchronous orbital arc and the radio spectrum are limited resources. If these resources are saturated, no further growth of satellite communications will be possible. Since demand projections indicate that the saturation of conventional satellite systems will soon be reached, it is imperative that new spectrum- and arc-conservation means be developed, so that communications services can expand.

When completed in 1990, NASA's ACTS program will have developed a mature, space-qualified base of technology from which industry can draw new communications satellite capabilities. Implementation of this technology in the operational systems of the 1990's will help ensure continued growth of the U.S. communications satellite industry and enhance its position as a leader in advanced satellite technology.

## POTENTIAL APPLICATIONS OF ADVANCED SATELLITE COMMUNICATIONS

- Wideband data services
  - Data transfer
  - Batch processing
  - Data entry
- Low- and medium-speed data service
  - Data entry
  - Remote job entry
- Interactive transmission
  - Inquiry response
  - Private time sharing
  - Commercial time sharing
- Packet switching
- Electronic funds transfer
- Electronic mail
  - Restricted access networks
  - Open access networks
  - Mailbox services
  - Facsimile
  - Communicating word processors
  - TWX and Telex
  - Mailgram
  - Telegram
- Secure voice
- Private line voice
- Public telephone service
- Business telephone service
- Radio program transmission
- Mobile radio telephone
- CATV distribution
- Teleconferencing
- Interactive home video
- Public broadcasting systems
- Commercial video distribution
- Education video networks
- Commercial video distribution
- Commercial video network trunking
- Occasional video program distribution

NASA
RCA
TRW
COMSAT
ADVANCED COMMUNICATIONS TECHNOLOGY SATELLITE

## ACTS CONTRACTOR TEAM

**RCA ASTRO ELECTRONICS**
- PRIME CONTRACTOR
- SYSTEM ENGINEERING, INTEGRATION, & TEST

**RCA**
- SPACECRAFT BUS
- FLIGHT SYSTEM INTEGRATION & TEST

**TRW**
- MULTIBEAM COMMUNICATIONS PACKAGE

**COMSAT**
- GROUND SYSTEM
- OPERATIONS & MAINTENANCE

MOTOROLA
- BASEBAND PROCESSOR

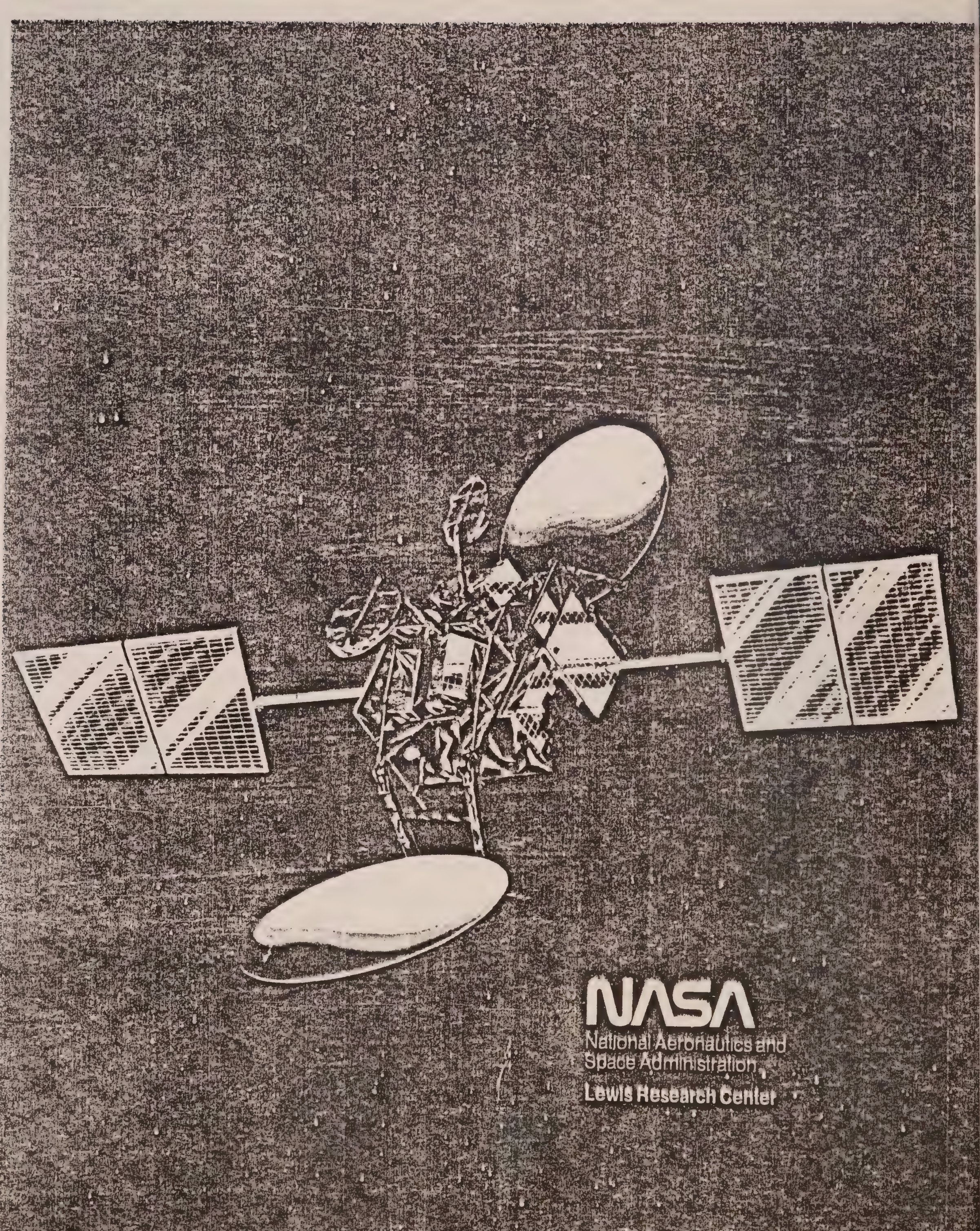
HUGHES
- TRAVELING WAVE TUBE

ELECTROMAGNETIC SCIENCES
- BEAM FORMING NETWORK

- FIVE-YEAR DEVELOPMENT CONTRACT FOR ACTS SYSTEM WAS SIGNED IN AUGUST 1984.
- LAUNCH IS SCHEDULED FOR SECOND-HALF OF 1989.
- TWO-YEAR EXPERIMENTS OPERATION PERIOD PLANNED AFTER LAUNCH.

For Further Information Contact:

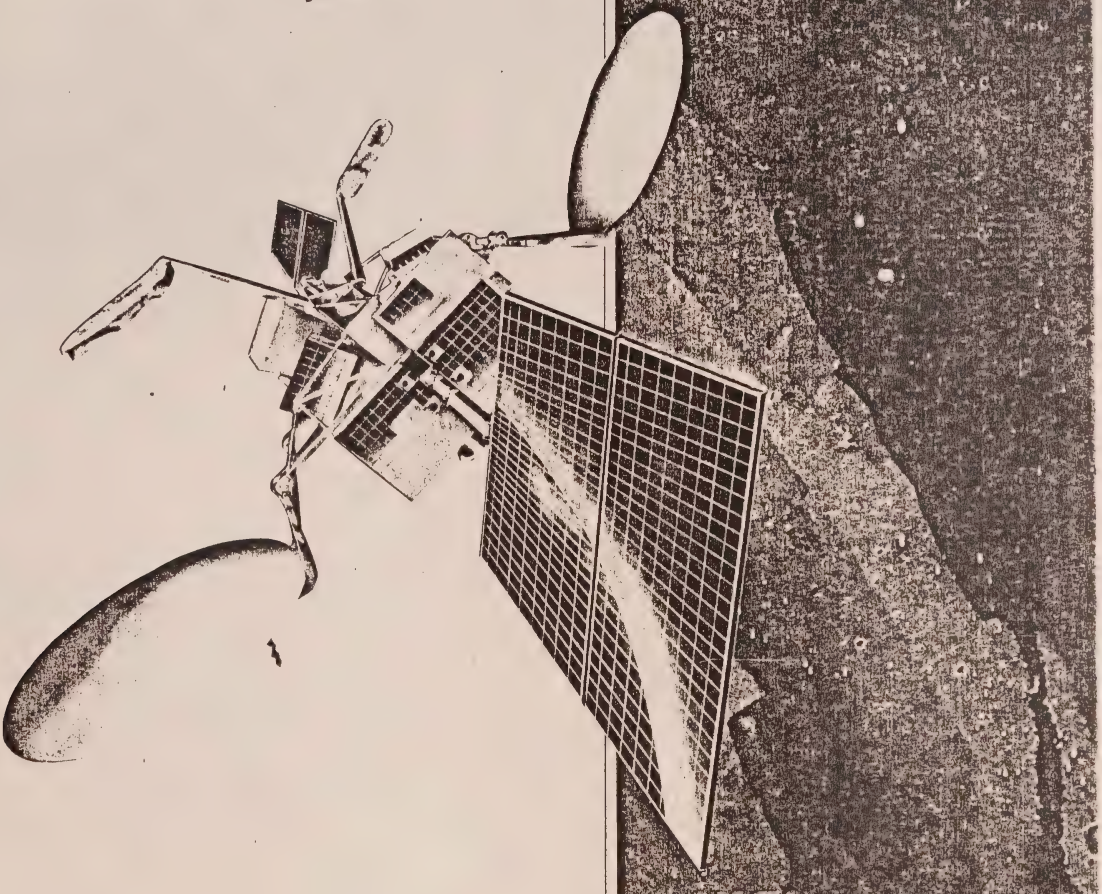
Ronald J. Schertler (MS 54-6)
ACTS Project Experiments Manager
NASA Lewis Research Center
21000 Brookpark Road
Cleveland, OH 44135
(216) 433-4000 Ext. 792


NASA
National Aeronautics and
Space Administration
Lewis Research Center

# ACTS

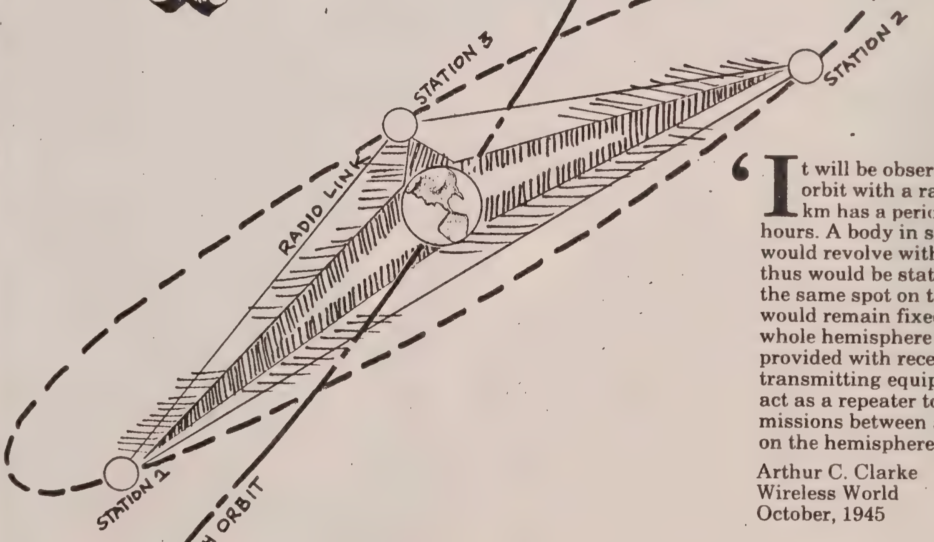
Advanced
Communications
Technology
Satellite

## The Next Generation of Space Communications



NASA
RCA
COMSAT
TRW
MOTOROLA

# Space Communications began with a concept in 1945 by Arthur C. Clarke

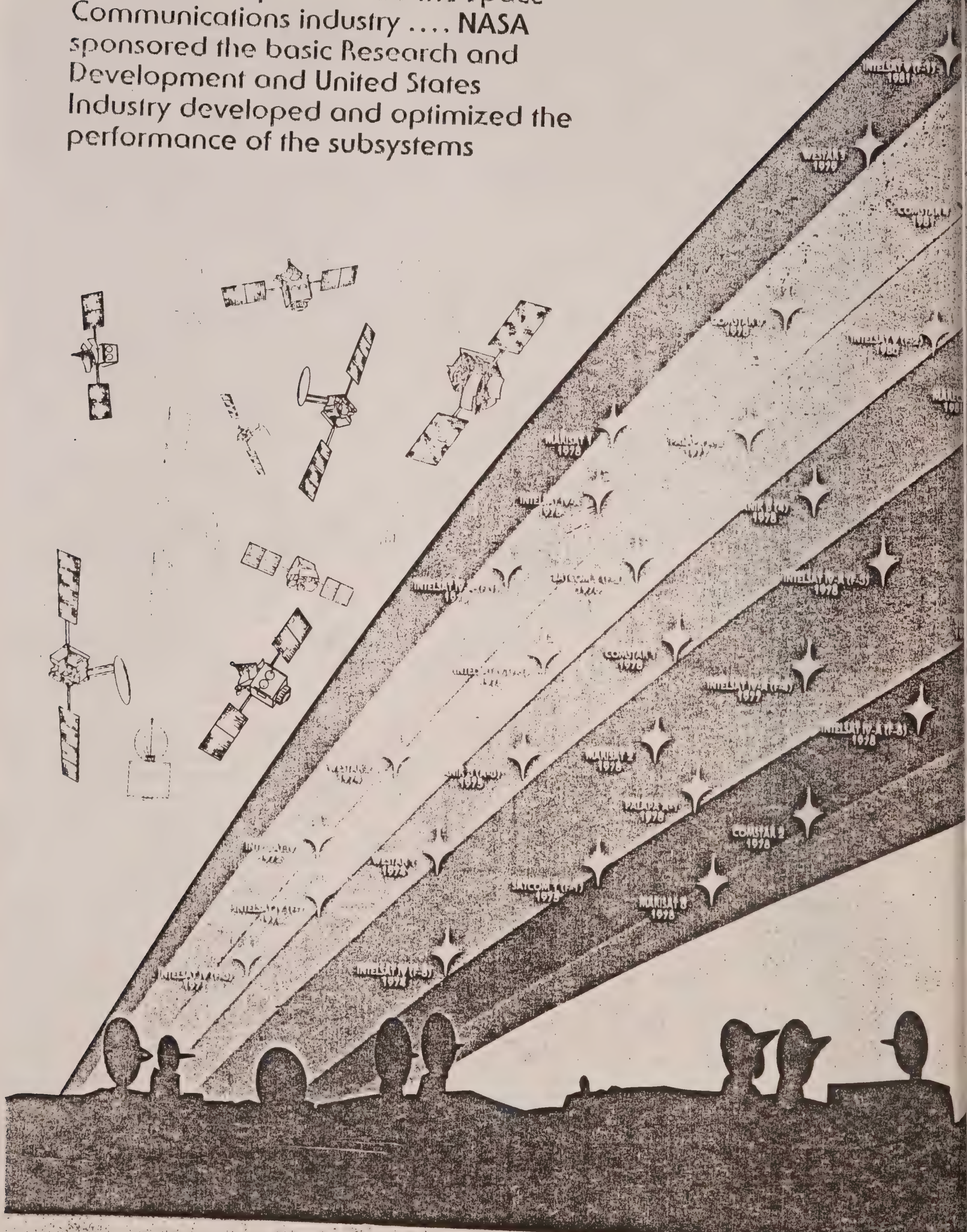


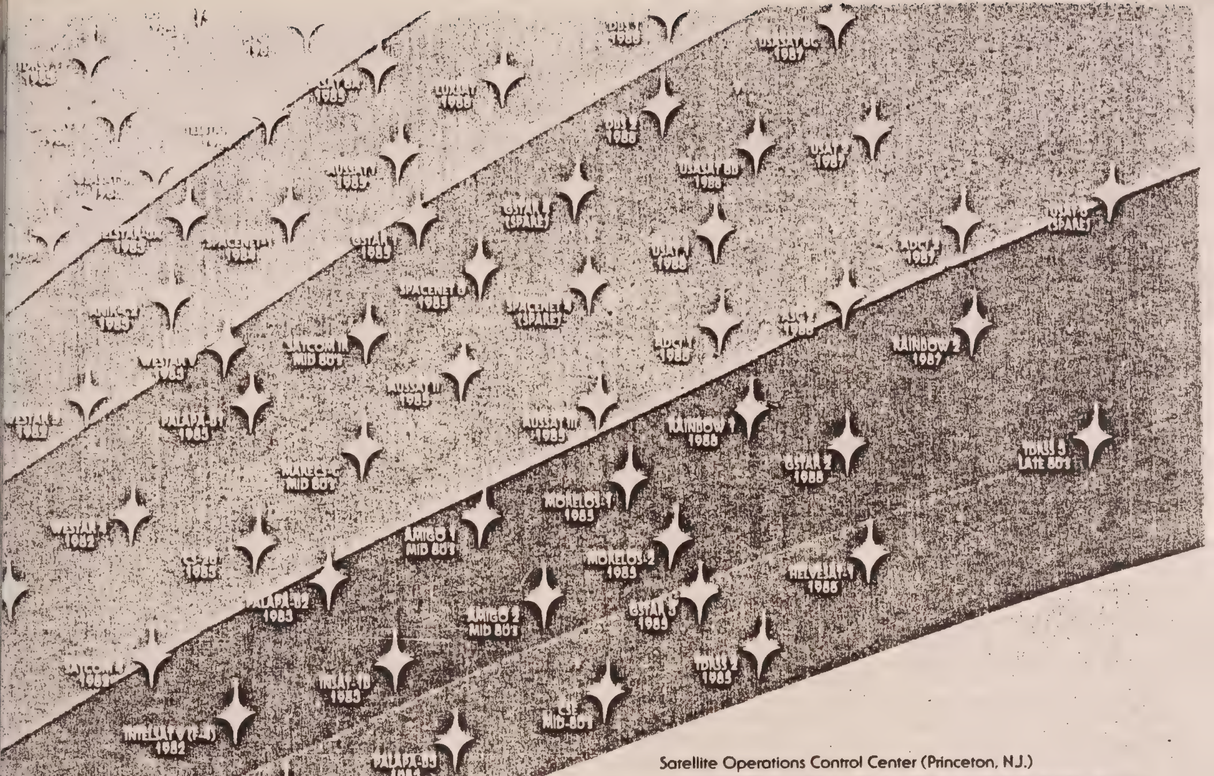

"It will be observed that ... (an) orbit with a radius of 42,000 km has a period of exactly 24 hours. A body in such an orbit ... would revolve with the earth and thus would be stationary above the same spot on the planet. It would remain fixed in the sky of a whole hemisphere ... It could be provided with receiving and transmitting equipment and could act as a repeater to relay transmissions between any two points on the hemisphere beneath ..."

Arthur C. Clarke
Wireless World
October, 1945

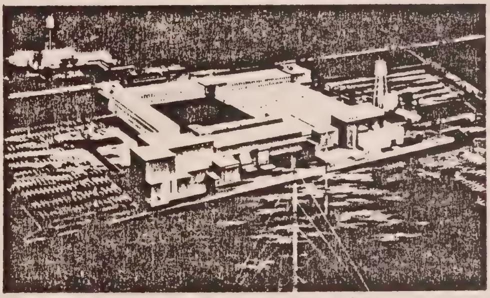
The United States recognized the potential of Space Communications And NASA became the prime mover in a series of experimental communications satellites.
1958
SCORE • the orbiting ATLAS with President Eisenhower's Christmas message demonstrated one-way transmission from space
N.A.S.A.
1960
ECHO • which demonstrated two way reflected transmission
1960
COURIER • which accepted and stored data for later transmission to ground
1962
RELAY • which received and transmitted simultaneously from low earth orbit
1963
SYNCOM • the first communications satellite at geosynchronous altitude
1974
ATS-6 • which demonstrated the full technology and capability of communications satellites
1976
CTS • which demonstrated direct broadcasting and Ku-band technology
Each of these programs was a significant milestone in the development of practical space communications

... which exploded into the Space Communications industry .... NASA sponsored the basic Research and Development and United States Industry developed and optimized the performance of the subsystems



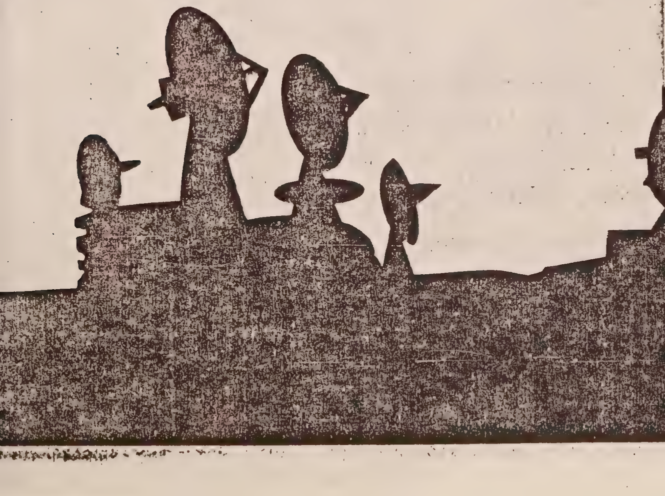


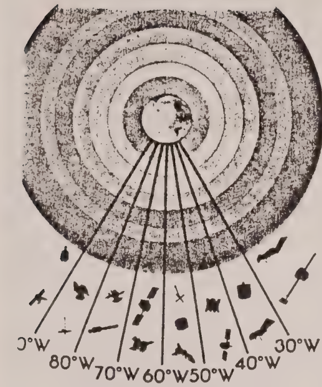

Satellite Operations Control Center (Princeton, N.J.)



Earth receiving stations for the space communications industry also adds to the Gross National Product. Their proliferation has been dramatic and tens of thousands of these stations are currently in place.

Telemetry, Tracking and Control Station (Guam)






## The current generation of Communications Satellites is rapidly saturating orbital slots and frequency bands

NASA sponsored highly focused R&D programs aimed at developing and demonstrating this technology.

Baseband Processing - a high speed digital switchboard in the sky for efficient use of time and transponder capability via message routing.

Multiple Beam Antenna - rapidly reconfigurable covering the entire U.S. to serve all users with optimum efficiency.

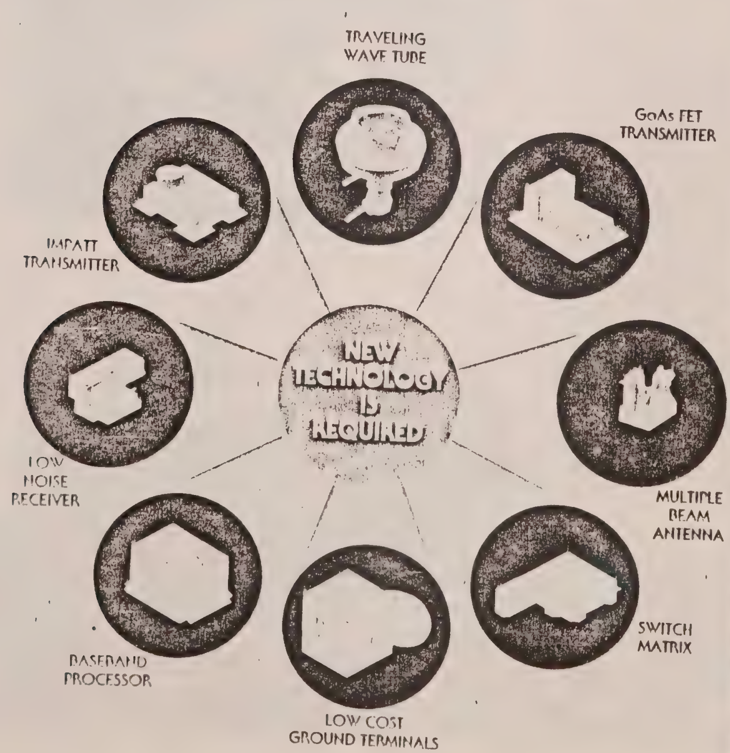
Microwave Matrix Switch - for trunk line reconfiguration to handle high traffic and high volume data via point-to-point communications.

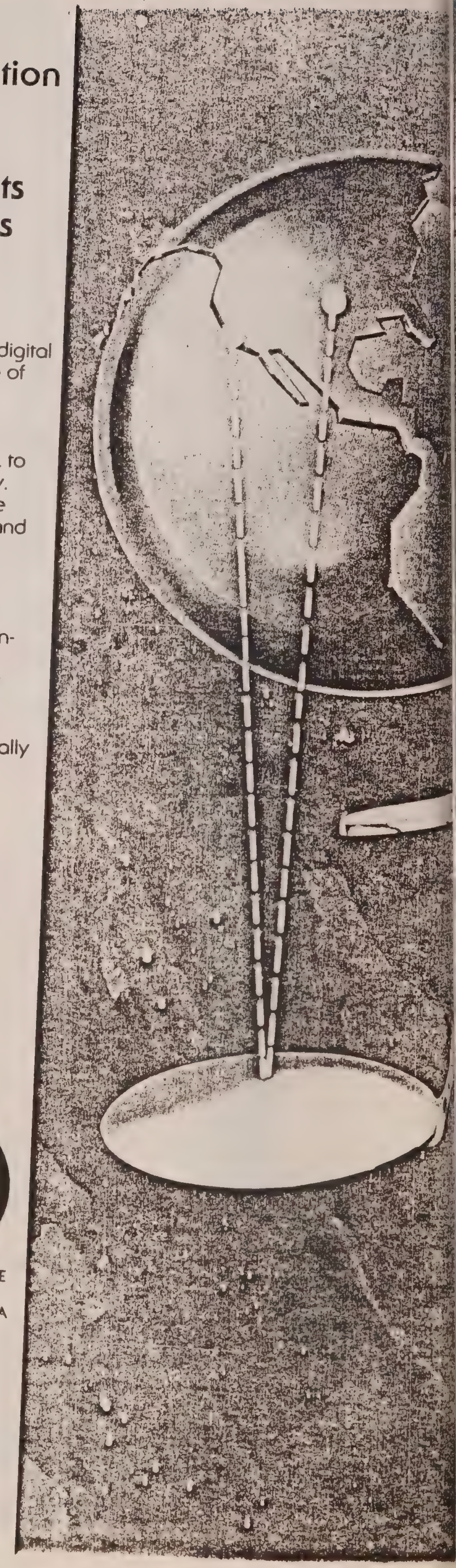
Time Division Multiple Access (TDMA) - efficient ground system architecture to generate timing access order for the on-board baseband processor.

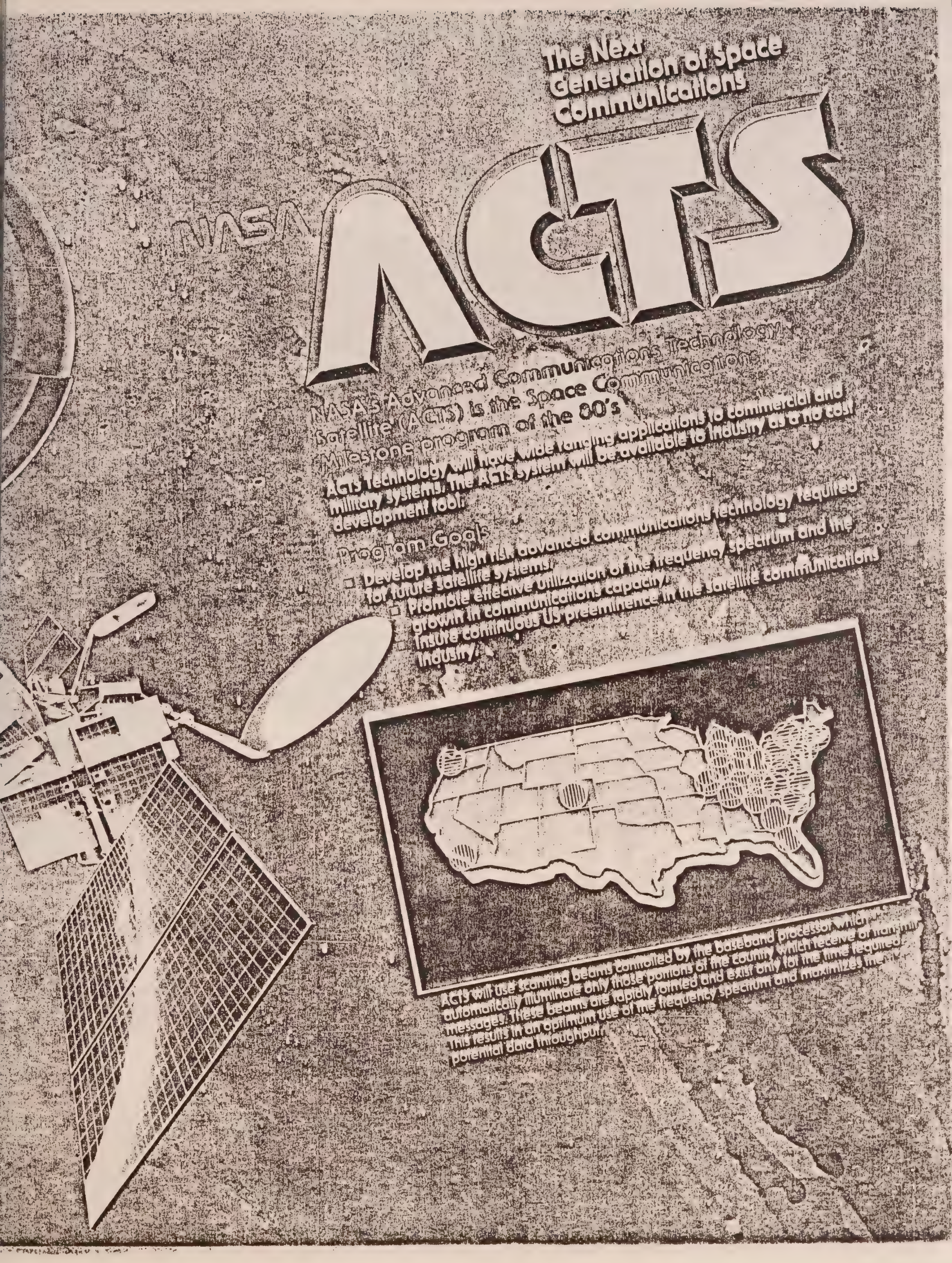
Advanced Receivers/Transmitters - low noise/high reliability components for transponder technology development.

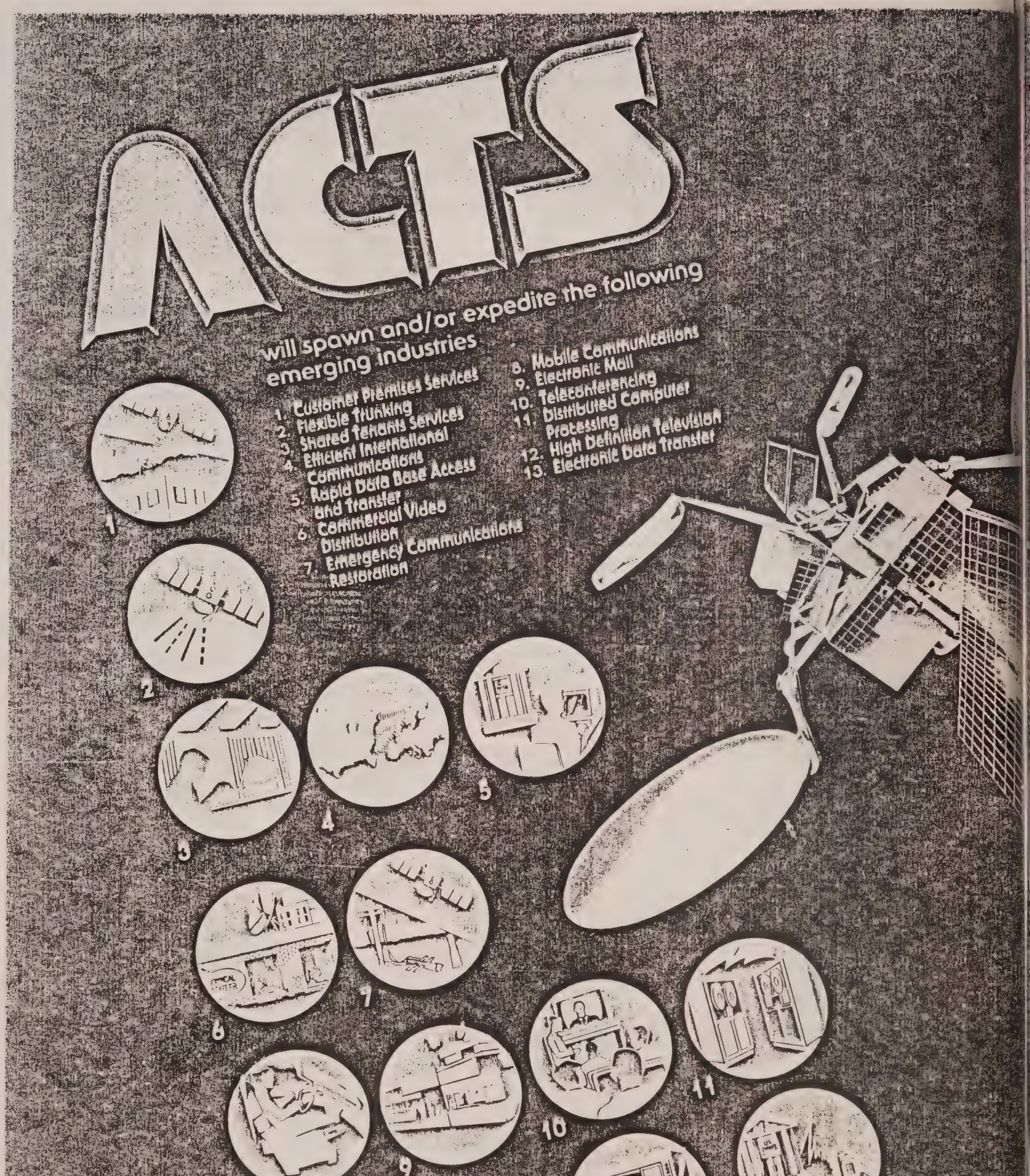
Rain Compensation System - automatically adjusts to uplink and downlink fades.

## ew technology in ɔace Communications required that ptimizes the transfer f information



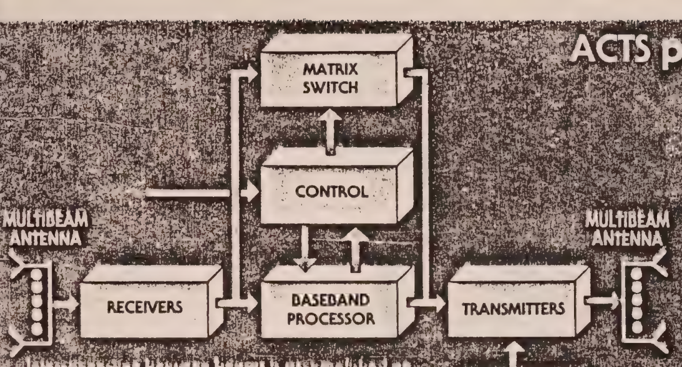




The Next Generation of Space Communications
NASA
ACTS
NASA's Advanced Communications Technology Satellite (ACTS) is the Space Communications Milestone program of the 80's
ACTS Technology will have wide ranging applications to commercial and military systems. The ACTS system will be available to industry as a no cost development tool.
Program Goals
Develop the high risk advanced communications technology required for future satellite systems.
Promote effective utilization of the frequency spectrum and the growth in communications capacity.
Insure continuous US preeminence in the satellite communications industry.
ACTS will use scanning beams controlled by the baseband processor which automatically illuminate only those portions of the country which receive or tran messages. These beams are rapidly formed and exist only for the time required. This results in an optimum use of the frequency spectrum and maximizes the potential data throughput.


ACTS
will spawn and/or expedite the following emerging industries
1. Customer Premises Services
2. Flexible Trunking
3. Shared Tenants Services
4. Efficient International Communications
5. Rapid Data Base Access and Transfer
6. Commercial Video Distribution
7. Emergency Communications Restoration
8. Mobile Communications
9. Electronic Mail
10. Teleconferencing
11. Distributed Computer Processing
12. High Definition Television
13. Electronic Data Transfer
1
2
3
4
5
6
7
8
9
10
11
12
13

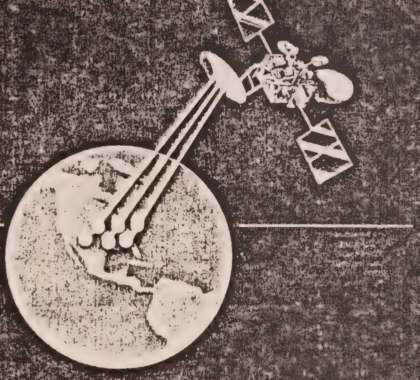
# ACTS performance characteristics

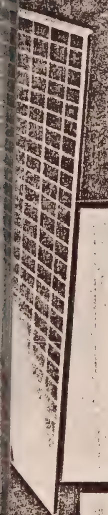
ACTS communications system employs a scanning multibeam antenna, in conjunction with advanced switching and processing systems, to concentrate communications capacity into narrow beams.




Interconnection between beams is accomplished on board the satellite by separate switching schemes supporting two distinct operational modes:

- Baseband Processor Mode = 64 kbps message sorting and routing
- Microwave Switch Mode = IF switching of trunk circuits





## System Performance

- √ 27.5 = 30.0 GHz uplink 17.7 = 20.2 GHz downlink
- √ Satellite switched TDMA with DAMA; FDMA
- √ BER better than $10^{-6}$
- √ FADE sensing 20 and 30 GHz downlink beacons

## Spacecraft Characteristics

**Baseband Processor Mode**

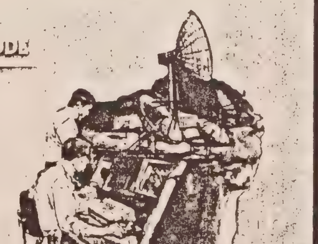
- Two scanning spot beams
- Total capacity 220 Mbps/beam
- Uplink burst rate 27.5 & 110 Mbps
- Downlink burst rate 220 Mbps
- FDM/SSTDMA with SMSK modulations
- Rain compensation by burst rate reduction and FEC coding.

**Microwave Matrix Switch Mode**

- Three fixed beams
- Total capacity 220 Mbps/beam
- maximum burst rate 220 Mbps
- Rain compensation by transmitter power management.

## Ground Terminal Characteristics

| | BASEBAND PROCESSOR MODE | | MATRIX SWITCH MODE |
|---|---|---|---|
| Access Method | FDM/TDMA/DAMA | | SS-TDMA/DAMA |
| Burst Rate, MBPS | | | |
| Uplink | 27.5 | 110 | 220 |
| Downlink | 220 | 220 | 220 |
| Number of Channels | 8 | 2 | [illegible] |
| Antenna Size, m | 3 | 5 | 5 |
| Transmit Power, W | 20 | 20 | 250 |
| Fade Compensation | FEC and Burst Rate Reduction | | Power Control |



# ACTS

## Experiment Period

A two year experimentation period is planned after launch, during which the capabilities of the ACTS spacecraft and ground system will be made available to the public and private sectors - corporations, universities and government agencies - to test and evaluate the key technologies at the ACTS system.

1994

1993

Dc

1992

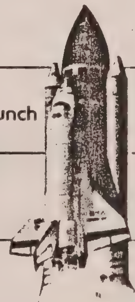
1991

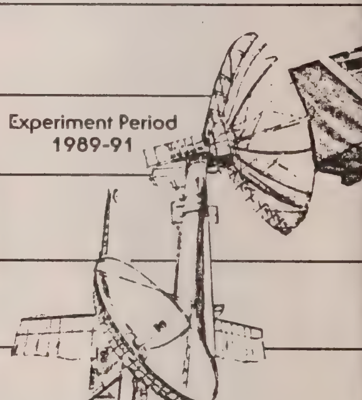
Experiment Period
1989-91

1990

Shuttle Launch
1989

1989





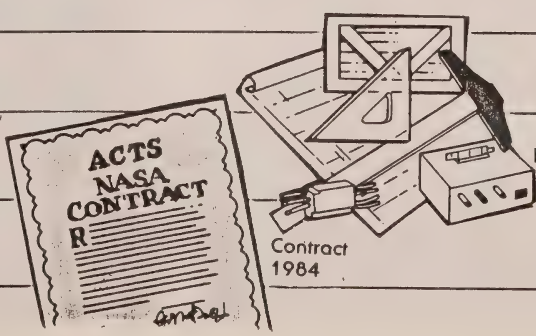
1988

1987

1986

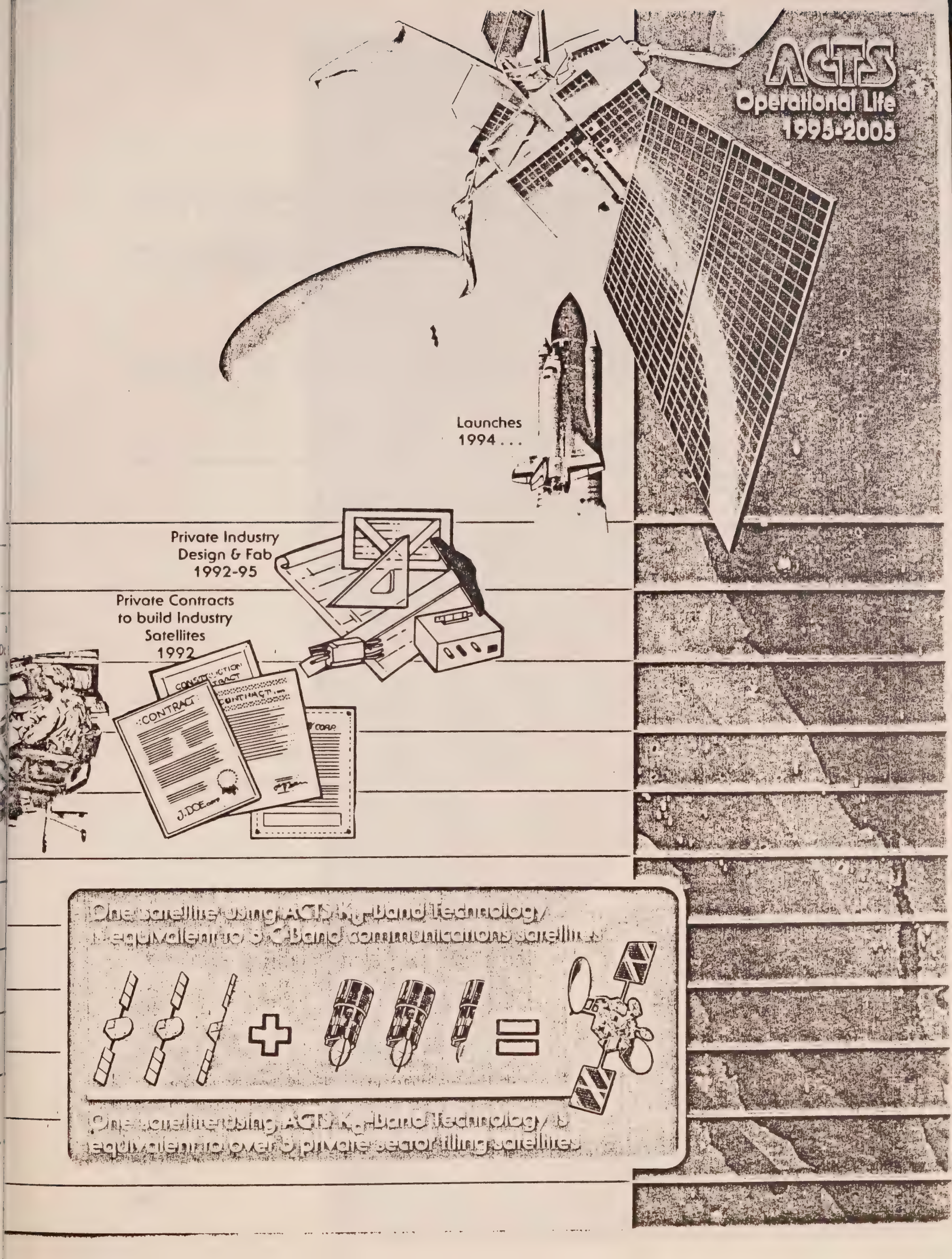
Design & Fab
1984-89

1985




Contract
1984

1984


ACTS
Operational Life
1995-2005
Launches
1994 . . .
Private Industry
Design & Fab
1992-95
Private Contracts
to build Industry
Satellites
1992
CONSTRUCTION CONTRACT
CONTRACT
CONTRACT
J.DOE corp
CORP


Lithographed in USA

3

# Advanced Communications Technology Satellite (ACTS)

## NOTICE OF INTENT FOR EXPERIMENTS

Communications Division
Office of Space Science and Applications
NASA Headquarters
Washington, D.C. 20546

March 1983

REVISED NOVEMBER 1984

NASA
National Aeronautics and Space Administration

ADVANCED COMMUNICATIONS
TECHNOLOGY SATELLITE (ACTS)

NOTICE OF INTENT FOR EXPERIMENTS

Communications Division
Office of Space Science and Applications
NASA Headquarters
Washington, DC 20546

March 1983
Revised November 1984

CONTENTS

## I. INTRODUCTION - THE ACTS EXPERIMENT PROGRAM

The National Aeronautics and Space Administration (NASA) is conducting an Advanced Communications Technology Satellite (ACTS) Program to advance the high risk technology required to ensure continued United States' preeminence in the field of satellite communications. The objectives of the ACTS Program are to develop and validate the technology required to enable growth in the capacity and effective utilization of the frequency spectrum and to effect new and innovative uses for satellite communications. The ACTS spacecraft is presently scheduled for launch into geostationary orbit by the Space Transportation System (Space Shuttle) in 1989. (A list of abbreviations used in this document is found on page 17.)

The ACTS communications technology payload will incorporate the high risk technologies necessary to permit more efficient use of orbit and spectrum resources and to allow for new forms of communication data transfer. Operation will be in the 30/20 GHz frequency band. A nominal two-year period for experiments has been planned. The technology developed under the ACTS Program will be usable in multiple frequency bands and will be applicable to a wide range of future communication systems required by NASA, other government agencies and U. S. industry.

A primary goal of the ACTS Program is to make available to the public and private sectors (corporations, universities and government agencies) the capabilities of the ACTS spacecraft for experimentation. At this time, it is the intent of NASA to consider all experiments technically and scientifically relevant to the basic objectives of the ACTS Program and for which the ACTS System can accommodate. NASA will develop the flight system and provide access to the ACTS space segment at no cost to the experimenter. Each experimenter will be responsible for the conduct and funding of their experiment.

The purpose of this Notice of Intent (NOI) for Experiments document is to a) identify those organizations interested in experimenting with the Advanced Communications Technology Satellite and b) determine insofar as possible, what the experiment characteristics and requirements would be. The NOI is soliciting only an expression of intent to conduct an experiment and a preliminary description of the proposed experiment. No resource commitment from the responding organization is required at this time. The commitment would be required later in the process in response to the NASA Experiment Opportunity Notice.

Sections II and III provide further details on the objectives and background of the ACTS experiment program. Section IV discusses the NOI response dates. Section V presents details of the ACTS Experiment system, and the responsibilities of NASA and experimenter in the ACTS program process. Sections VI and VII present the format of responses and the review process for the NOI.

## II. NOTICE OF INTENT OBJECTIVES

### A. OBJECTIVES

The Advanced Communications Technology Satellite Project is one element of the NASA Communications Program in which NASA develops and experimentally evaluates through flight experimentation advanced multiple beam communications technology. The Project will advance the proof-of-concept laboratory models currently under development through flight experiment verification, verify feasibility of the system concepts that provide spectrum conservative communications technology and verify availability and reliability of communications circuits operating in the 30/20 GHz frequency band.

The advanced technology to be incorporated into the ACTS spacecraft will include a multiple beam antenna; baseband processor; high-speed, intermediate frequency (IF) Matrix switch, low noise receivers and multipower traveling wave tube transmitters. Experiments are invited to provide quantitative on-orbit performance data as well as reliability and stability measurements related to the advanced technology components implemented in the flight system and associated ground terminals.

Additional experiments are invited to evaluate system aspects. These include satellite pointing accuracy, beam pattern and gain stability; uplink and downlink margins for both high and low data throughput terminals; and satellite channel capacity, stability and co-channel interference. Propagation impairments, especially rain attenuation, can be extremely severe in the Ka-band. Adequate characterization of these impairments under flight conditions could have a significant impact on spacecraft design and earth station implementation. Collection of propagation statistics from various parts of the country are necessary to adequately characterize fading, rain attenuation, scattering, scintillation and depolarization. Measurements are necessary with and without site diversity. Performance evaluation of various rain fade compensation techniques such as uplink and downlink power control and forward error correction coding must be examined. Frequency re-use performance should be evaluated for orthogonal polarizations and beam spatial separations.

The basic capabilities and performance of the high and low data throughput terminals must be evaluated. Key technical/performance characteristics such as availability, switching/routing capabilities, network control, system synchronization and timing, and site diversity gain must also be experimentally verified.

A number of representative experiment subcategories have been identified for the ACTS Experiment Program. These experiment subcategories and their relationship to the technology to be developed within the ACTS Program are briefly described in the following section. It should be noted that this experiments subcategory listing is not meant to be exhaustive. Experiments within the scope of the ACTS Program but not identified in this subcategory listing are certainly invited.

## B. EXPERIMENT CATEGORIES

### 1. Flight System Technology Experiments

Experiments to evaluate the performance and reliability of the specific multibeam communications subsystems which are included onboard the ACTS spacecraft, such as the multiple beam antennas, the baseband processor, IF matrix switch, low noise receivers and multipower traveling wave tube transmitters.

### 2. Ground Experiments

Experiments that evaluate the performance of the NASA ground station, Master Control Station, and Experimenter's Station.

### 3. Acquisition, Tracking, and Synchronization

Experiments that evaluate acquisition, tracking and TDMA synchronization and timing considering flight system station-keeping accuracy and antenna-pointing accuracy.

### 4. Enhancement of Link Availability/Rain Compensation Techniques

Experiments to evaluate 30/20 GHz availability and performance improvements achievable with such techniques as earth stations with spatial diversity, adaptive power control and forward error correction.

### 5. Transmission Impairments

Experiments that evaluate system impairments, particularly interference, that arise as a function of beam separation.

### 6. Propagation Experiments

Experiments to develop propagation statistics to characterize propagation impairments such as fading, rain attenuation, scattering, scintillation and depolarization for all CONUS rain zones. Experiments to evaluate quantitatively the impact of such propagation impairments on the ACTS system performance.

7. System Network Control

Experiments to evaluate the performance and efficiency of a TDMA Demand Assigned Multiple Access (DAMA) System, and to evaluate network access and control as a function of signal quality and time. Experiments to evaluate the performance of various communications protocols.

8. Low Burst Rate Earth Stations

Experiments to evaluate reliability, availability and performance of low cost, low burst rate earth stations.

Expressions of interest are solicited in response to this NOI to conduct experiments such as outlined above and/or consistent with the ACTS program objectives.

## III. BACKGROUND

As the present space communication systems have evolved, modest but significant improvements have been made to the capacity or number of circuits per satellite via industry sponsored technological improvements. However, to meet the expected large increase in demand for communications in the 1990's, a major advance in technology centered around spacecraft systems employing multiple narrow spot beam antennas will be necessary. The use of these types of antennas will permit the re-use of the allocated spectrum and will therefore offer the potential for large increases in system capacity. The interconnection between spot beams will be performed by switching systems on board the spacecraft. These antenna and switching systems technologies, which are generic for existing as well as new frequency bands, require flight experimentation as an essential part of their technology development process. The NASA ACTS Program sponsors the development of this high risk advanced space communications technology.

The NASA ACTS Program has been structured in the three phases as shown in Figure 1. Beginning in 1979 both market and operational studies were conducted. The market studies (ref. 1-5) assessed future market demand for satellite services as well as determined the mission need for advanced operational systems. The operational system studies (ref. 6-12) established capability of 30/20 GHz systems to satisfy projected satellite communications needs and identified critical technology to be developed. Key proof-of-concept advance technologies (ref. 13-35) are currently under development through a NASA Industry Program. As illustrated in Figure 1, these are: a 20 GHz multipower traveling wave tube transmitter, a 20 GHz GaAs FET transmitter, multiple beam (fixed and scanning spot) antennas, an IF Matrix switch, a satellite baseband processor, a 30 GHz low noise receiver, a 20 GHz GaAs IMPATT transmitter,

and low cost ground terminal components. The contracts for the technology development have been structured to be completed by end of 1984.

The ACTS System, which comprises both a flight and ground system, will be designed and developed during the 5 year System Development Phase and will be launched in 1989 by the Space Transportation System from the Kennedy Space Center. Following launch and on-orbit checkout, a two year Experiment Phase is planned. The experimenters for the flight program will include communications carriers, government agencies, universities and others identified and selected through this NOI and a succeeding ACTS Experiment Opportunity Notice.

## IV. NOTICE OF INTENT RESPONSE PERIOD

NASA will accept responses to the NOI at any time.

## V. REQUIREMENTS AND CONSTRAINTS

### A. ADVANCED COMMUNICATIONS TECHNOLOGY SATELLITE SYSTEM TECHNICAL FEATURES

The Advanced Communications Technology Satellite Project includes the design, development and operation of an Advance Communications Technology Satellite System. The ACTS System includes the ACTS spacecraft, a combined Master Control Station (MCS) and a single NASA ground station. The experimenter will provide their own earth terminals necessary to conduct their respective technology experiments. Figure 2 is a schematic of the ACTS System.

The ACTS spacecraft will be shuttle launched in 1989 into geostationary orbit for a two-year experimentation mission. The advanced technology to be incorporated into the communications payload includes a high gain multibeam antenna, a high speed IF matrix switch, a baseband processor, low noise receivers and multipower traveling wave tubes transmitters. Operation will be in the Ka (30/20 GHz) frequency band; 27.5 to 30.0 GHz uplink and 17.7 to 20.2 GHz downlink. A block diagram of the communications payload incorporating this technology and meeting the major system requirements is shown in Figure 3. The ACTS System shall be capable of providing communications between ground terminals having either low burst rate (LBR) channels or high burst rate (HBR) channels.

The multibeam antenna and its associated components will provide both scanning and fixed beams. Scanning beam/Low Burst Rate coverage will be provided simultaneously by two independent beams to two contiguous sectors and isolated nodes (150 mile diameter) outside of either sector.

Nominally, the scanning beams will each cover an area of approximately 10 percent of CONUS. The coverage provided by the fixed beam/HBR links can include the area covered by the LBR scan beams (which may be stopped to provide fixed beam), a fixed beam on MCS as well as two additional fixed beams which are not part of the scan beam coverage pattern. For planning purposes the beam patterns of both the scanning and fixed beams are shown in Figure 4. Consideration will be given to experimenter inputs in the selection of final beam locations.

The NASA Ground Station will consist of a primary station with both high and low burst rate capability as well as a diversity station for telemetry, tracking and command (TT&G) only and a terrestrial link interconnect between the primary and diversity sites. All master control functions for the ACTS system will be provided by the NASA Ground Station and will be referred to as the Master Control Station (MCS). The Master Control Station will provide spacecraft control, network control and experiment management and data recording. All message traffic will be requested, set-up and programmed by the MCS. Furthermore the MCS will distribute all the information necessary to support both the HBR and LBR communication links and coordinates the incoporation of rain compensation measures. Channel assignments are made on a demand basis according to a reservation scheme for both HBR and LBR channels under control of the MCS where the access link is via the satellite. Maintenance of synchronization is accommodated in a closed loop fashion by each terminal. The NASA Ground Station will be located at the NASA Lewis Research Center (LeRC) in Cleveland, Ohio.

Experimenter terminals can be deployed in either a Low Burst Rate (LBR) or High Burst Rate (HBR) configuration. Table 1 presents the baseline characteristics of the ACTS terminals. The information rates (throughput) are given in MBPS and the burst rates are given in MSPS as measured at the output of the modulators. The following two sections describe the HBR and LBR terminal characteristics summarized in Table 1, in more detail.

1. <u>High Burst Rate Ground Terminal</u>

The fixed beams/High Burst Rate (HBR) system will provide communications among the HBR terminals on a TDMA basis. Interconnectivity among different beams is accomplished by the MW-matrix switch on the satellite, which allows TDMA traffic bursts transmitted in one beam to be routed to others as required by the network traffic plan. The switch configurations used for beam interconnections are programmable and will be changed to optimize traffic flow. A burst may be sent to multiple destinations by implementing point-to-multipoint or broadcast switch connections on the satellite. Interconnectivity between the HBR terminals will be provided for up to three active nodes. For the ACTS System, a node is defined as one or more HBR stations within the same beam. Within the active three node HBR network, nine HBR stations will be capable of

operating with up to three stations per beam. All HBR beams will use the same frequency. The coverage provided for the HBR links will include the areas covered by the LBR scan beams (which may be stopped to provide fixed beams), a fixed spot beam on MCS location as well as two additional fixed beams which are not part of the scan beam coverage.

The uplink and downlink burst rates will be 220 MSPS with a minimum nominal throughput capacity (information rate) including overhead of 220 MBPS. The system has the capability to operate at 500 MSPS but at a reduced availability. Uplink and downlink gains will be 52 dB. Rain compensation can be provided by both uplink and downlink power augmentation and by site diversity to maintain the BER at less than $10^{-6}$. Power augmentation can be automatically implemented to accommodate uplink rain fades of up to 18 dB and/or downlink rain fades up to 8 dB whenever the rain fade rate is less than 1dB/second. The HBR system will be designed to provide 220 MSPS burst rate service to ground terminals having a nominal antenna diameter of five meters, a High Power Amplifier (HPA) of approximately 250 watts and a noise figure of 4 dB for the Low Noise Receiver (LNR). A block diagram of a typical HBR terminal is shown in Figure 5.

2. Low Burst Rate Ground Terminal

The scanning beam/Low Burst Rate (LBR) system will provide communications among the LBR terminals on a FDM/TDMA basis through the use of a multibeam antenna and a baseband processor (BBP) on board the flight system. The transmitted uplink bursts are frequency demultiplexed, demodulated, decoded (if appropriate), buffered, processed (digitally routed), reformatted, encoded (if appropriate) and remodulated on the spacecraft and transmitted to the designated areas. Interconnectivity between LBR terminals will be provided via the baseband processor on a circuit switched basis with a minimum equivalent circuit capacity of one 64 KBPS channel. That is, individual message traffic can be routed from any LBR terminal to any other LBR terminal. The LBR system will also be capable of distributing LBR traffic from any LBR terminal to a group of terminals. After the burst is received on-board by the BBP, individual messages from that terminal are sorted by destination and each message is then downlinked to the proper location.

LBR coverage will be provided simultaneously by two orthogonally polarized independent flight system scanning beams and one fixed beam on the MCS location. Each scanning beam will provide complete coverage for a sector which includes approximately ten percent of CONUS as described above.

The LBR system will accommodate, as a minimum, 40 LBR terminals within the total scanning beam coverage area during one scan period. In addition, a maximum of 30 LBR terminals will be capable of operating within one scan period of either scanning beam. Provision will be made

to accommodate up to 8 LBR terminals per beam dwell location. The total throughput capacity of the LBR system without forward error correction (FEC) will nominally be 440 MBPS. Each scanning beam will have a maximum throughput capacity of 220 MBPS, which is provided on the uplink by a combination of 27.5 MSPS and 110 MSPS burst rate FDM channels. The system will be capable of switching between the 27.5 MSPS and the 110 MSPS burst rate channels within a beam dwell. On the downlink, data is transmitted over a single 220 MSPS burst rate channel. Minimum uplink and downlink gain will be 48 dB. Rain compensation can be provided by forward error correction (FEC) and data rate reduction. Total link margins with FEC and data rate reduction can be 15 dB on the uplink and 6 dB on the downlink. FEC and data rate reduction can be applied on an automatic basis to rain degraded uplinks and/or downlinks in order to maintain the BER at $10^{-6}$.

The LBR system is designed to provide services to the 110 MBPS ground terminals having a nominal antenna size of 5 meters, a HPA of approximately 10 watts and LNR noise figure of 4 dB. LDR service for the 27.5 MBPS ground terminals is designed for a nominal antenna size of 3 meters, a HPA of approximately 10 watts and a LNR noise figure of 4 dB. A block diagram of a typical LBR terminal is shown in figure 6. It is not intended that the HBR and LBR systems operate simultaneously, although limited operation of the two may be possible. In addition, provisions for communication services during eclipse and direct sun outages are not planned.

3. Flight System

The flight system can be assumed to be located at 100° West longitude in geostationary orbit. The final orbit location will be specified at a later date. The desired orbit location of the flight system will be maintained to within ± 0.05 degrees in both North-South and East-West directions for the mission duration.

The MCS will provide on orbit TT&C. The MCS will provide and perform all functions associated with the on-orbit control and operation of the flight system (mission operations), with the control and operation of the communications network (network operations) and with the conduct of the experiments. Facilities at the MCS will include automatic data processing equipment, receiving and transmitting equipment and display equipment. Spacecraft performance data will be recorded and distributed to the experimenters as part of the experiment operation system. The spacecraft data measurement requirements should be identified in the experimenter's response to this NOI.

4. Additional Information

The NASA technology development pogram is involved in a continuing analysis of ACTS Experimenter terminal requirements, including alternate designs and estimated costs. A document which defines the requirements a ground terminal must meet to be compatible with the ACTS system will be available at a later date.

B. INVESTIGATORS

Responses to this NOI must designate one individual as the Principal Investigator (PI) who will be the single point of contact with NASA. Except as provided in this NOI, the PI will assume responsibility for the selected experiment. The PI will be responsible for the team of Co-Investigators (Co-I's), if Co-I's are designated. Co-I's should not be designated unless they have a specific role in the experiment. The designation "Co-Principal Investigator" is to be avoided. The PI is responsible for developing the experiment plan, assembling the appropriate ground instrumentation and software, attending experimenter's meetings, and managing the conduct of the experiment. The PI is responsible for reporting the analyzed results of the experiment in a timely manner.

C. RESPONSIBILITIES

1. NASA - NASA will furnish the ACTS spacecraft, a NASA ground Station which includes the Master Control Station and access to the ACTS space segment at no cost to the experimenter. The NASA ground station will consist of a high burst rate capacity, a low burst rate capacity and a diversity station site for TT&C and a terrestrial interconnect link. The MCS will provide spacecraft control, network control and experiments management and control. The LeRC MCS will be used to control the spacecraft from placement at the orbital position through the conclusion of the experimental phase of the flight.

   It is planned that an Industry Ground Terminal Group will be formed to provide a source from which to purchase or lease ground terminals. In addition, NASA will also make available the designs and requirements for both the HBR and LBR ground terminals.

   The ACTS flight system is planned to be launched in 1989. After a period of on-station spacecraft checkout subsequent to launch, the flight system will be made available for a two-year period of operations for experiments. The LeRC will have management responsibility for all experiments and will coordinate the planning and scheduling of all experiments through the MCS. Data for component performance evaluation for the advance technology components aboard the spacecraft along with any pertinent spacecraft/MCS auxiliary correlating data necessary for the various technology and system experiments will be collected and archived in the MCS and distributed to the appropriate investigators.

2. EXPERIMENTERS - The experimenters will be required to designate a PI and to conduct their own experiments. Although the present NOI solicits only a preliminary proposal and an expression of

intent to conduct an experiment, it is nevertheless incumbent upon the experimenter to consider the future responsibilities of submitting a final proposal and conducting the experiment(s). The experimenter's organization via the PI will be responsible for providing the resources required to plan, coordinate, conduct the proposed experiment and to report the analyzed results of the experiment.

### D. DATA REPORTING

The Principal Investigator is responsible for reporting the analyzed results of the experiment in a timely manner. At the present time, brief monthly status reports are envisioned along with a comprehensive Final Report. Periodic experiment meetings will be held and experimenters will be required to attend and present an updated experiment status report. It should be noted that data for technology and system experiments conducted by NASA for principal investigators using NASA-owned facilities will be made available to all principal investigators.

## VI. RESPONSE SUBMISSION INFORMATION

Questions regarding the NOI should be referred to:

Dr. Daniel L. Brandel
Acts Program Manager
NASA Headquarters, Code EC
Washington, D. C., 20546
(202) 453-1505

or

Ronald J. Schertler
ACTS Project Experiments Manager
(MS-54-6)
21000 Brookpark Road
Cleveland, OH 44135
(216) 433-4000, Ext. 792

### A. FORMAT OF RESPONSE

The Response should include the following:

a. Cover letter introducing the experiment and signed by an official of the Principal Investigator's institution authorized to certify institutional support and sponsorship of the investigation.

b. Title Page containing the title of the experiment; PI's name, organizational affiliation and telephone number; and a brief abstract of the proposed experiment; and anticipated source of funding.

c. Concept Sketch of the proposed experiment showing spacecraft earth terminal(s) locations desired and major elements of the experiment.

d. Experiment Definition containing the following sections: Title of the Experiment; Experiment Category; Principal Investigator & Co-Investigator(s) Name(s), Organization(s), Address(es) and Telephone Number(s); Objective; Justification; Special Requirements for the Spacecraft and Master Control Station including network and access requirements; Ground Terminals (Number, Type and Location); Approach and Measurement (Parameters the experimenter will measure and record; parameters which the experimenter desires NASA to measure on the spacecraft and/or in the MCS; measurement techniques, data throughput, and frequency and duration of the measurements); Schedule; and Experiment Duration (i.e., the periods of time during the day needed to conduct the experiment and the frequency of those periods.

Four copies of the Response's Title Page, Concept Sketch and Experiment Definition along with the cover letter should be sent to:

Daniel L. Brandel
ACTS Program Manager
Code EC-4
National Aeronautics & Space Administration
Washington, D.C., 20546

B. EXPERIMENTER NOTIFICATION

NASA will notify each PI when the response has been received. After review and evaluation of all responses, NASA will compile a listing of all suitable experiments and distribute this to all PI's.

## VII. RESPONSE EVALUATION AND SELECTION PROCEDURES

One of the objectives of the ACTS Program is to make available to the public and private sectors (corporations, universities and government agencies) the capabilities of the ACTS spacecraft for experimentation. At this time, it is the intent of NASA to consider all experiments technically and scientifically relevant to the basic objectives of the ACTS Program and for which the ACTS System can accommodate. NASA will notify any experimenter if there are any perceived problems in the conduct of the experiment.

## VIII. REFERENCE LIST


### Market Demand Studies

1. 18/30 GHz Fixed Communications System Service Demand Assessment; NASA CR 159546, 159547, and 159548; Western Union Telegraph Company, July 1979.

2. 30/20 GHz Fixed Communications Systems Service Demand Assessment; NASA CR 159619, 159620, and 159621; ITT, August 1979.

3. 30/20 GHz Net Accessible Market Assessment; NASA CR 159837; Western Union Telegraph Company, February 1980.

4. Market Capture by 30/20 GHz Satellite Systems; NASA CR 165231, and 165232; ITT, 1981.

5. Worldwide Satellite Market Demand Forecast, Task II, Western Union Telegraph Co., June 1981.

### Operational System Studies

6. Concepts for 18/30 GHz Satellite Communication System Study; NASA CR 159625 and 159680; Ford Aerospace & Communications Corp; November 1979.

7. 18 and 20 GHz Fixed Service Communications Satellite System Study; NASA CR 159627 (Executive Summary and Final Report) Hughes Aircraft Company, September 1979.

8. 30/20 GHz Mixed User Architecture Development Study; NASA CR 159686 and 159687; TRW Inc., October 1979.

9. Applications of Advanced On-Board Processing Concepts to Future Satellite Communications Systems; NASA CR 159682 and 165684; June 1979; NASA CR 165155, October 1980; The Mitre Corporation.

10. Study of Advanced Communications Satellite Systems Based on SS-FDMA; NASA CR 159778; General Electric Co., October 1980.

11. Next Generation Communications Satellite Multiple Access and Network Studies; Columbia University, July 1980.

12. Planning Assistance for the 30/20 GHz Program (a) Study of Intersatellite Links, Task VI, Final Report, COMSAT, November 1981.

ACTS System Requirement Reports

13. Requirements Determination to Demonstrate 30/20 GHz Communications Systems, Hughes Aircraft Company, Final Report Volumes 1 through 4, July 1981.

14. Requirements Determination to Demonstrate 30/20 GHz Communication Systems, TRW, Inc., Final Report Volumes 1 through 3, July 1981.

15. 30/20 GHz Concept Design, Ford Aerospace & Communications Corp. Final Report, June 1981.

16. 30/20 GHz Concept Study, RCA Astro-Electronics Corp. Final Report, July 1981.

17. 30/20 GHz Concept Design, General Electric Co., Final Report, July 1981.

18. Planning Assistance for the 30/20 GHz Program; Western Union

    (a) Task 2 Report; 30/20 GHz Communication System Functional Requirements, December 1980.

    (b) Task 3 Report; Review of Specified Conceptual Designs and Recommendations, July 1981.

    (c) Task 4 Report; Review of Hughes/TRW Baseline and Alternate Design Concepts, March 1981.

    (d) Task 5 Report; Review and Critique of Phase II Detailed Designs, August 1981

    (e) Task 6 Report; Review and Critique of the Technology Readiness Contractors' Effort, August 1981.

    (f) Task 7 Report; Development and Review of Experiment Program Plan, September 1981.

    (g) Final Report; Volumes I, II and III, September 1981.

19. Preliminary Experiment Requirements for the 30/20 GHz Experimental Satellite, Aerospace Corp.

    (a) Final Report, September 1981.

Technology Development Reports

20. 30/20 GHz Spacecraft Multi-Beam Antenna System, Ford Aerospace.

(a) Review #1, October 1980.

(b) Review #2, April 1981.

21. 30/20 GHz Spacecraft Multi-Beam Antenna System, TRW.

(a) Task 1 Report, February 1981.

(b) Task 2 Report, April 1981

(c) Task 3 Report, April 1981

22. 30/20 GHz Communications Satellite Low Noise Receiver, ITT, Task 1 Report, October 1980.

23. Spacecraft IF Switch Matrix for Wideband Service Application in 30/20 GHz Communications Satellite Systems, Ford Aerospace.

(a) Task 1 Interim Report, November 1980.

(b) Task 1 Final Report, May 1981.

(c) Proof-of-Concept Model, Final Design Review, November 1981.

24. 30/20 GHz Satellite Switching Matrix Development, General Electric.

(a) Task 1 Report, November 1980.

(b) Task 2 Report, March 1981

(c) Proof-of-Concept Model, Final Design Review, November 1981.

25. 30/20 GHz Communications System Baseband Processor, Motorola.

(a) Task 1 Report, January 1981.

(b) Task 4 Report, January 1981.

(c) Task 3 Report, Preliminary Studies and Tests of Critical Designs and Technologies, July 1981.

(d) Task II 1987 Technology Communication System Design, Final Report, September 1981.

26. 17.7 - 21.1 GHz, 75 Watt Traveling Wave Tube, Hughes Electron Dynamics Division.

(a) Industry Briefing Report, November 1980.

(b) Industry Briefing Report, May 1981.

27. 30/20 GHz Communications Satellite Low Noise Receiver, LNR.

(a) Task 1 Report, October 1980.

(b) POC Design Summary, April 1981.

28. Spacecraft Multibeam Antenna System for 30/20 GHz Task I & II Report, Ford Aerospace, March 1982.

29. K-Band High Power Latching Switch, Final Report, TRW, December 1980.

30. 30/20 GHz Communications Satellite Low Noise Receiver, Task III Breadboard Test Results, ITT, April 1982.

31. Multiple Beam Antenna System Task IV & VI Design Review, TRW, April 1981.

32. Spacecraft IF Switch Matrix for Advanced Technology Communications Satellite System, Breadboard Development of Critical Switch Technology, Task III, Final Report, Ford Aerospace, April 1982.

33. Spacecraft Switch Matrix for Wideband Service Applications in 30/20 GHz Communications Satellite System, IF Switch Matrix Design Using 1987 Technology, Task II, Final Report, Ford Aerospace, November 1981.

34. 30/20 GHz Satellite Switching Matrix Development, IF Switch Matrix Breadboard Testing Results, Task III, General Electric Co., March 1982.

35. 30/20 GHz Transponder Study Final Report, Hughes Aircraft Co., December 1980.

Other

36. Industry Briefing for 30/20 GHz Communications Project; NASA Lewis Research Center, November 1980.

37. Industry Briefing for Advanced Satellite Communications; NASA Lewis Research Center, May 1981.

38. Industrial Briefing for Advanced Communications Technology Program; NASA Lewis Research Center, April 1982.

## IX ABBREVIATIONS

| | |
|---|---|
| ACTS | Advanced Communications Technology Satellite |
| BER | Bit Error Rate |
| CoI | Co-Investigator |
| CONUS | Continental United States |
| DAMA | Demand Assigned Multiple Access |
| dB | Decibel |
| DEMOD | Demodulator |
| FDM | Frequency Division Multiplying |
| FEC | Forward Error Correction |
| FET | Field Effective Transistor |
| GaAs | Gallium Arsenide |
| GHz | Gigahertz |
| HBR | High Burst Rate |
| HPA | High Power Amplifier |
| IF | Intermediate Frequency |
| IMPATT | Impact Ionization Avalanche and Transit Time (Diode) |
| KBPS | Kilobits Per Second |
| LBR | Low Burst Rate |
| LeRC | Lewis Research Center |
| LNA | Low Noise Amplifier |
| LNR | Low Noise Receiver |
| MBPS | Million Bits Per Second (Information Rate) |
| MCS | Master Control Station |
| MOD | Modulator |
| MSPS | Million Symbols Per Second (Burst Rate at Output of Modulator) |
| NASA | National Aeronautics and Space Administration |
| PI | Principal Investigator |
| POC | Proof of Concept |
| RFP | Request for Proposal |
| TDMA | Time Division Multiple Access |
| TT&C | Telemetry, Tracking & Command |
| TWTA | Traveling Wave Tube Amplifier |

## ACTS PROJECT LIBRARY

A library containing documents and information of interest to potential experimenters has been established at LeRC and access will be generally available during working hours. Arrangements for visiting this library may be made by contacting:

Ronald J. Schertler
ACTS Project Experiments Manager
NASA Lewis Research Center MS 54-6
Cleveland, Ohio 44135
216-433-4000, Ext. 792

Advanced notice (at least 24 hours) is required. A limited number of copies of certain documents will be available to experimenters. If no copies of a particular document are available, a master copy will be made available to experimenters for use or review in the library room or, if necessary, to borrow overnight or weekends for the purpose of duplication.

TABLE 1

BASELINE ACTS GROUND TERMINAL CHARACTERISTICS

| PARAMETER | BASEBAND PROCESSOR MODE | | MW SWITCH MATRIX MODE |
|---|---|---|---|
| BURST RATE (MSPS) | | | |
| UPLINK | 27.5 | 110 | 220 |
| DOWNLINK | 220 | 220 | 220 |
| ANTENNA SIZE (M) | 3 | 5 | 5 |
| G/T (DB/$^{O}$K) | 22 | 27 | 27 |
| HPA (WATTS) | 10 | 10 | 250 |
| NOMINAL BER | | $10^{-6}$ | |
| FADE COMPENSATION | FEC, BURST RATE REDUCTION | | POWER AUGMENTATION |

National Aeronautics and Space Administration

Lewis Research Center

## SPACE FLIGHT SYSTEMS DIRECTORATE

NASA

NASA ADVANCED COMMUNICATIONS TECHNOLOGY MAJOR PROGRAM ELEMENTS

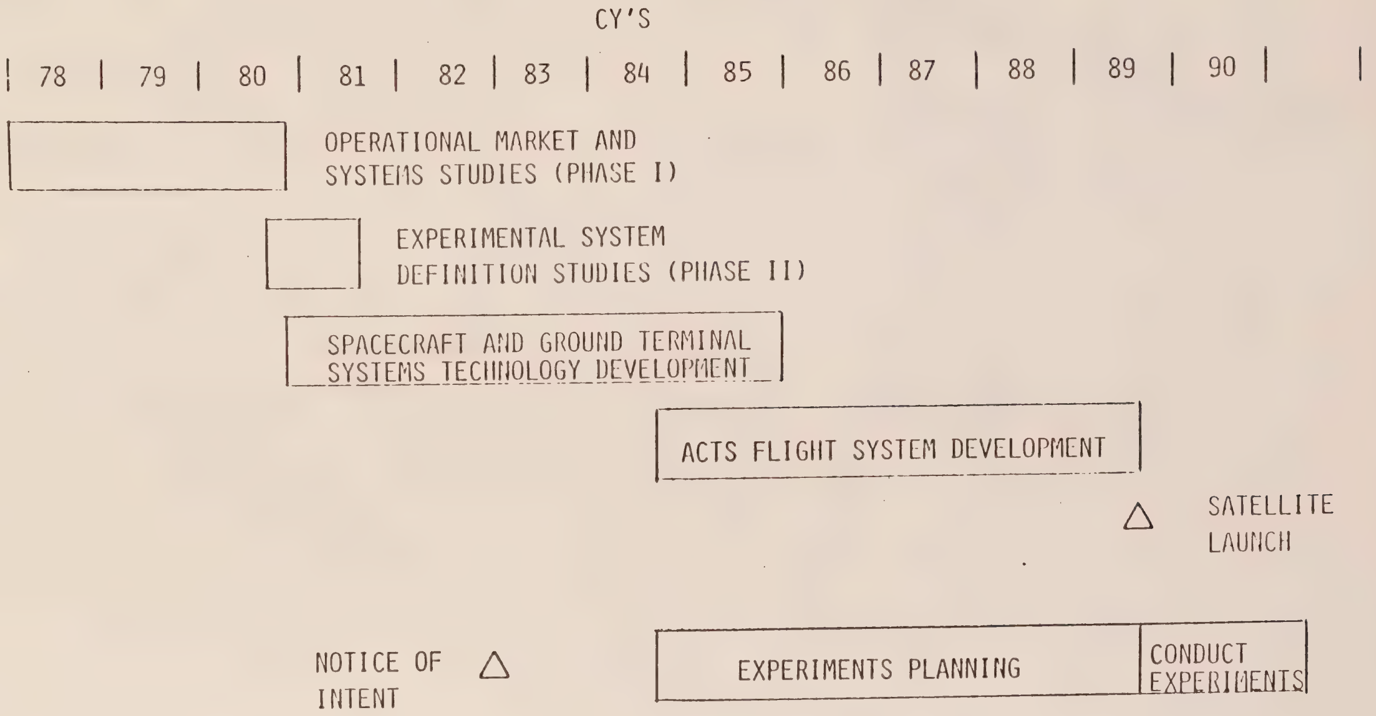



FIGURE 1 - NASA'S ADVANCED COMMUNICATIONS TECHNOLOGY SATELLITE (ACTS) PROGRAM

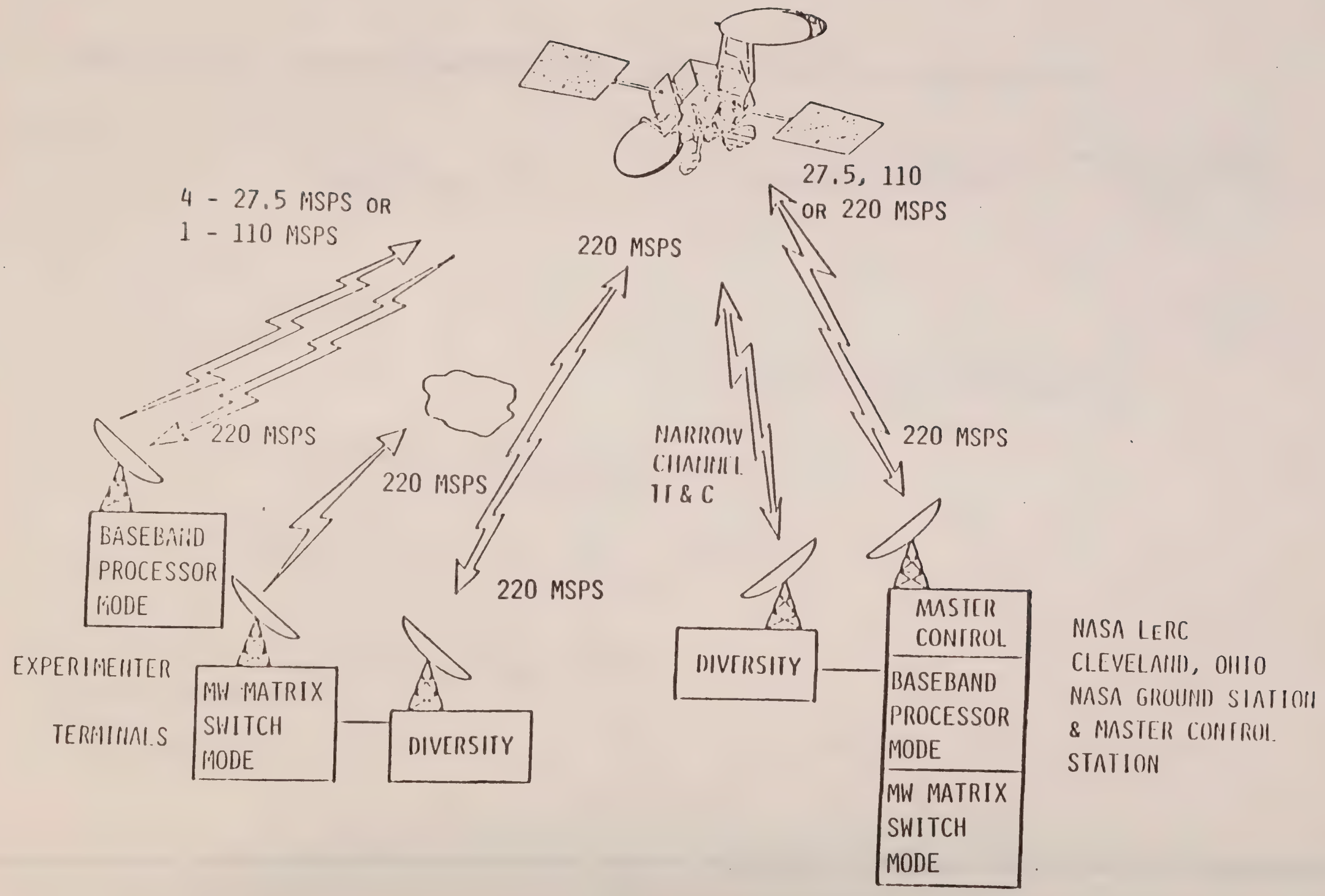



FIGURE 2. - SCHEMATIC OF ADVANCED COMMUNICATIONS TECHNOLOGY SATELLITE SYSTEM

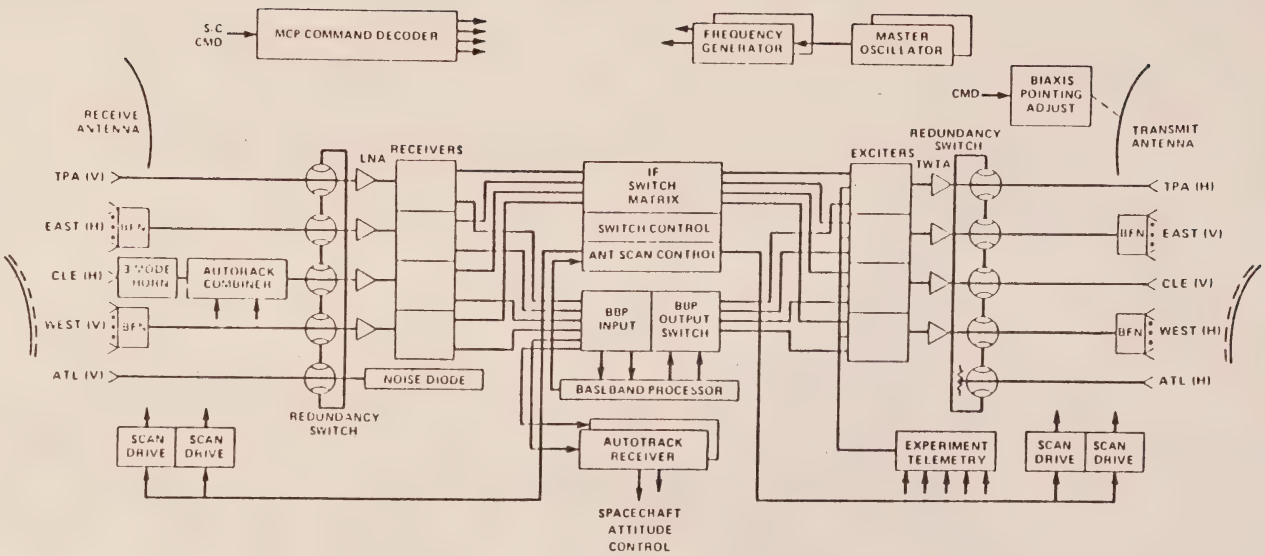



Figure 3. - Communications Payload for Advanced Communications Technology Satellite.

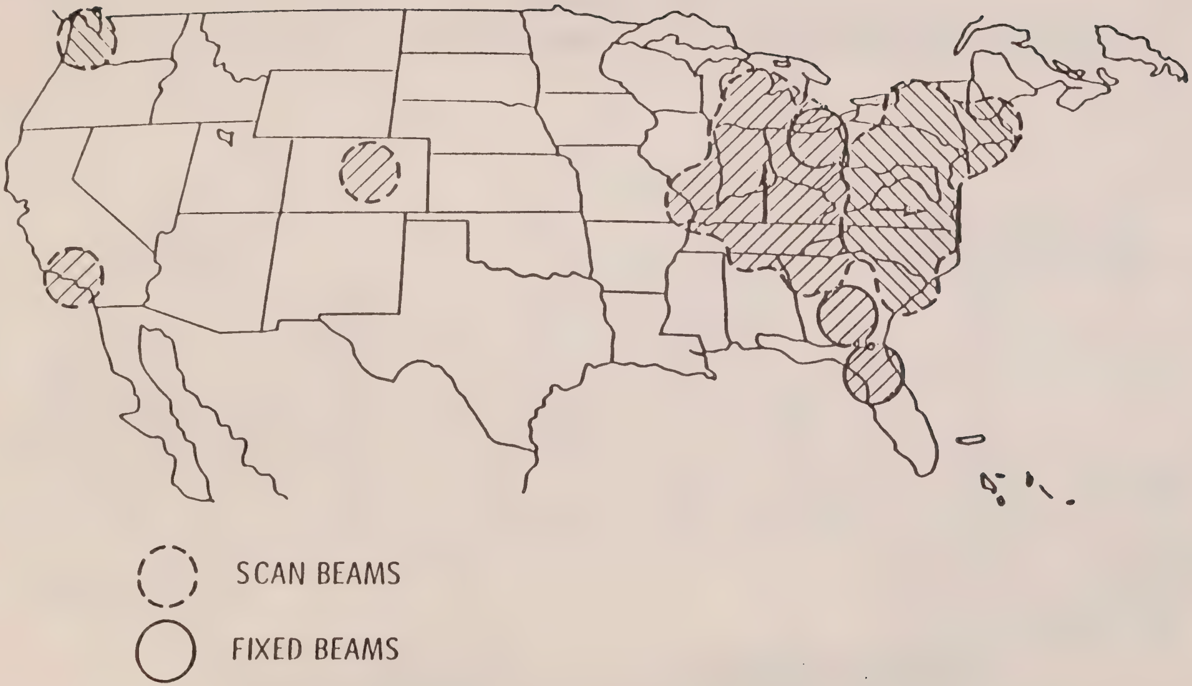



Figure 4. - Typical Advanced Communications Technology Satellite antenna coverage.

NOTE: ACTUAL SCAN AND FIXED BEAM LOCATION COVERAGE WILL BE DETERMINED BASED ON EXPERIMENTER REQUIREMENTS

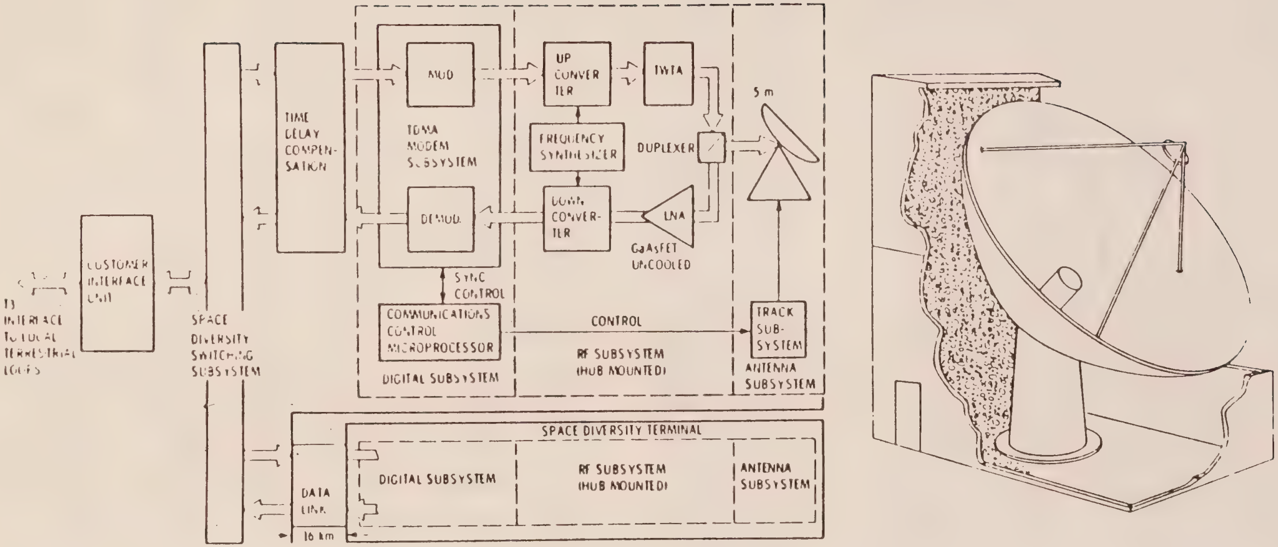



Figure 5. - Typical High Burst Rate (220 MSPS) Terminal Schematic

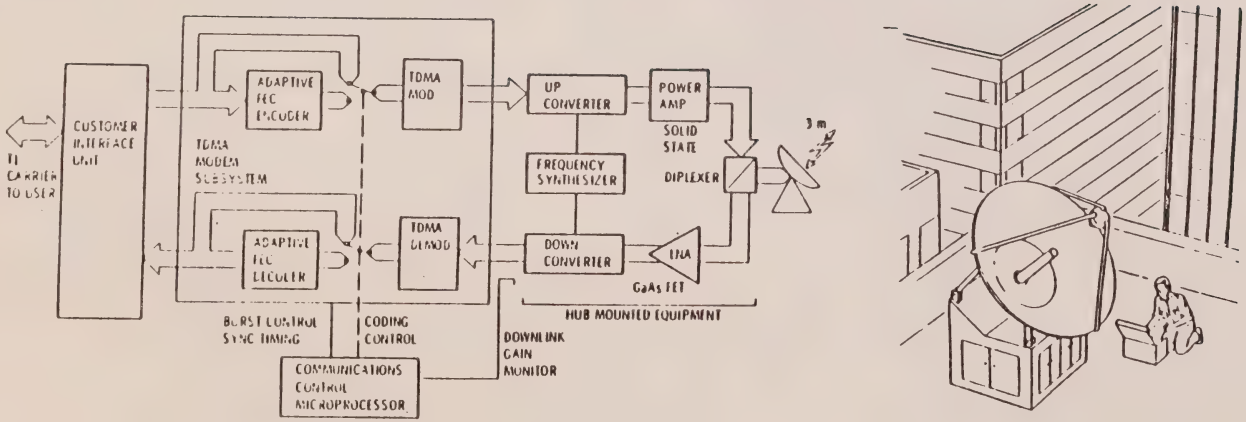



Figure 6. - Typical Low Burst Rate (27.5 MSPS) Terminal Schematic

National Aeronautics and
Space Administration

**Lewis Research Center**
Cleveland, Ohio
44135

4 NASA

Reply to Attn of: 6100

AEB 85-3
April 24, 1985

TO: Distribution

FROM: 6100/ACTS Project Experiments Manager

SUBJECT: Minutes for ACTS Experiments Meeting No. 1 on March 26, 1985

A previous ACTS Experiments Bulletin (AEB 85-2) dated March 6, 1985 provided information on the Advanced Communications Technology Satellite (ACTS) Experiments Meeting. This AEB (85-3) provides minutes for the First ACTS Experiments Meeting.

Summary

The Advanced Communications Technology Satellite (ACTS) Experiments Meeting No. 1 was held at the Hyatt Regency - Crystal City in Arlington, Virginia on March 26, 1985. There were six presentations by NASA, 89 visuals were used and were in the handout supplied to attendees. An ACTS color brochure was also provided. Three separate group discussions were held. Attendees numbered 114 from 45 industry/university organizations and eight government agencies including NASA.

The Agenda is given herein as Enclosure 1; it lists also the number of visuals used by each speaker that were included as a handout.

Enclosure 2 lists the attendees at the meeting. Noted on Enclosure 3 are the attendees at each of the three group discussions along with phone numbers.

Topics (Keyed to the Agenda)

A. Introductory remarks were given by R. Lovell, NASA Headquarters, Director Communications Division. Then D. Brandel, ACTS Program Manager at NASA Headquarters, discussed ACTS program goals and objectives.

B. Overall aspects of the ACTS project were explained by R. Gedney, NASA Lewis ACTS Project Manager. Organizations involved and schedule were reviewed.

C. R. Schertler, NASA Lewis Project Experiments Manager, discussed the variety of opportunities for experiments using communications technology embodied in ACTS.

D. Considerable time was spent by D. Wright in reviewing the important ACTS communications system. Spacecraft characteristics, antenna coverage, different modes, frequency plan, power control, link budget, ground terminal characteristics master control station were discussed.

E. Potential types of ground terminals for ACTS were discussed by R. Knight. In addition, he reviewed NASA component development activity applicable to ACTS. His final visual was not in the handout; it is included herein as Enclosure 4.

F. The ACTS experiments program was discussed by R. Schertler. It included NASA and experimenter responsibilities, listing of ACTS Experiments Development Team and a summary of responses to the Notice of Intent (NOI). There have been 49 such responses.

G. As noted on the Agenda (Enclosure 1) there were separate group discussions on experiments. The groups, chairmen, and number of attendees:

| Group | Chairman | Attendees |
|---|---|---|
| 1. Technology | D. Wright | 18 |
| 2. Propagation | R. Manning | 10 |
| 3. Systems & Applications | D. Brandel | 48 |

As noted previously, the attendees along with their phone numbers are given in Enclosure 3.

H. The NASA Associate Administrator for Space Science and Applications, Dr. Edelson, provided comments on the importance of ACTS for U.S. space communications and the need to utilize ACTS with meaningful experiments. He pointed out that the ACTS technology is useful not only for $K_a$ band but also for lower frequencies as well, in particular for $K_u$ band.

I. Summary remarks were given by D. Brandel who thanked those present for attending and the speakers for their presentations. He noted that a questionnaire would be issued to collect information relative to experiments. This questionnaire is the subject of forthcoming AEB 85-4.

Ronald J. Schertler

Ronald J. Schertler

4 Enclosures:
1. Agenda, 1 Page
2. Attendee List, 4 Pages
3. Attendee List for Group Discussions, 3 Pages
4. Additional Visual, 1 Page

WP00870

DISTRIBUTION - AEB 85-3

| | |
|---|---|
| AFSST/YHA | Captain Charles Peterson |
| AT&T Bell Laboratories | Robert J. Brown |
| Aerospace Corporation | Dr. James B. Woodford |
| Alternative Systems Laboratory | Alfred Pietrzyk |
| American Express | Larry Lake |
| American Medical Association | Carlos Martini, MD |
| American Medical Association | Dr. Roy Schwarz |
| American Satellite Company | Michael R. Helton |
| ANALEX | Patrick L. Donoughe |
| ANALEX | Michael Kerpchar |
| ANALEX | Robert Manning |
| Andrew Corporation | Thomas Charlton |
| Annenberg/CPB Project | Dr. Peter J. Dirr |
| Arizona State University | Lee C. Frischknecht |
| AVANTEK | David Norbury |
| Bendix Field Engineering | William Pfeiffer |
| Boeing Aerospace Company | Dean Gahagan |
| Boeing Aerospace Company | David Wax |
| Booz-Allen & Hamilton | Marc A. Polster |
| Carnegie Forum on Education & the Economy | Marc Tucker |
| Catholic Telecomm. Network of America | Wasyl M. Lew |
| Chamber of Commerce of the U.S.A. | Doug Widner |
| COMSAT General Corporation | Carrie Devieux, Jr. |
| COMSAT General Corporation | Elizabeth L. Young |
| COMSAT Laboratories | Dr. S. J. Campanella |
| COMSAT Laboratories | Larry Palmer |
| COMSAT Maritime Services Division | Daniel W. Swearingen |
| Colorado Video, Inc | David K. McIntosh |
| Consultant | Neil R. Helm |
| Department of Defense | Col. John Graves |
| Department of Defense | Major William Langford |
| Department of Defense | Richard Buehler |
| Department of Defense, T432 | Byron Keadle |
| DocuNet | Jim Wilson |
| E-Systems, Inc. | Samuel H. Hubbard |
| Equatorial Communications | Dr. Edwin Parker |
| Fairchild Communications & Electronics | Don Marcopulos |
| Fairchild Communications & Electronics | Ed Habib |
| Fairchild Communications & Electronics | Daynay Chakraborty |
| Federal Communications Commission | Bruno Pattan |

DISTRIBUTION - AEB 85-3

| | |
|---|---|
| Federal Express | Richard Braley |
| Federal Express | Preston Vorlicek |
| Ford Aerospace | Carl Hellman |
| GTE - Government Systems | Hans J. Tiller |
| GTE - Spacenet | David F. Piske |
| CTE - Spacenet | Sid Skjei |
| GTE - Spacenet | Young Kim |
| GTE - Spacenet | Myong Kim |
| GTE Laboratories, Inc. | E. P. Tweedy |
| GTE Sylvania | Henning Olesen |
| General Electric Company | Bruce K. Mitchell |
| General Services Administration | Gregory Bain |
| General Services Administration | Robert Shephard |
| General Services Administration | Robert J. Hofferty |
| Harris Corporation | Michael DeZego |
| IBM Federal Systems Division | Ralph J. Metz |
| Jet Propulsion Labs | Ernest K. Smith |
| John Hopkins University | Dr. Julius Goldhirsh |
| LNR Communications, Inc. | Julius Asmus |
| Library of Congress | Dr. Joseph Price |
| Library of Congress | Robert Carneal |
| Lockheed Palo Alto Research Labs | Dr. J. M. Zuinn |
| M/A - COM Research Center | Leonard S. Golding |
| M/A - COM Telecom Div. | Jay Hustead |
| MIT - Lincoln Lab. | Mike Carter |
| MITRE Corporation | Joe Fernandez |
| MITRE Corporation | Richard Smith |
| Maryland Public Television | Sidney Tishler |
| Mississippi Authority for ETV | F. Lee Morris |
| Motorola Inc., Govt. Elec. Group | Ron Thomas |
| Motorola Inc., Govt. Elec. Group | Dave Carroll |
| Motorola Inc., Govt. Elec. Group | A. Boyd Holmes |
| N and F Associates (Creighton University) | Frederick H. Brigham, Jr. |
| NBS/DOD Liaison | Brian C. Belanger |
| NASA Ames Research Center | Dr. Mary M. Connors |
| NASA Ames Research Center | Dr. Harry W. Jones |
| NASA Goddard Space Flight Center | S. H. Durrian |
| NASA Goddard Space Flight Center | Robert Fitzgerald |
| NASA Goddard Space Flight Center | Dr. Stanley Sobieski |
| NASA Headquarters | Dr. Burt Edelson |
| NASA Headquarters | Daniel L. Brandel |

DISTRIBUTION - AEB 85-3

| | |
|---|---|
| NASA Headquarters | Dominic Santarpia |
| NASA Headquarters | William T. Kondik |
| NASA Headquarters | Robert R. Lovell |
| NASA Lewis Research Center | Dr. Richard T. Gedney |
| NASA Lewis Research Center | John G. Bluck |
| NASA Lewis Research Center | James E. Cake |
| NASA Lewis Research Center | William H. Hawersaat |
| NASA Lewis Research Center | Howard D. Jackson |
| NASA Lewis Research Center | Rodney M. Knight |
| NASA Lewis Research Center | Mary Ann Peto |
| NASA Lewis Research Center | Leonard Rizzolla |
| NASA Lewis Research Center | Ronald J. Schertler |
| NASA Lewis Research Center | David L. Wright |
| NASA Lewis Research Center | Bruce G. Lindow |
| NASA Lewis Research Center | Brian D. May |
| NASA Lewis Research Center | Dale E. Pope |
| NASA Marshall Space Flight Center | Dr. James Green |
| National Communications System | Kenneth B. Boheim |
| National Communications System | Al Bartko |
| National Fire Protection Assn. | James Smalley |
| New York Institute of Technology | Sir John Manniello |
| ORI, Incorporated | Ronald Wallace |
| Public Service Satellite Consortium | Deb Gilman |
| Public Service Satellite Consortium | Karen Hutcheson |
| Public Service Satellite Consortium | Kim McDaniel |
| Public Service Satellite Consortium | Anderlene White |
| Public Service Satellite Consortium | Louis Bransford |
| Public Service Satellite Consortium | Mary D. Clark |
| Public Service Satellite Consortium | H. Rex Lee |
| Public Service Satellite Consortium | Suzanne Douglas |
| RCA | Dave Wilkinson |
| RCA - American | Sandra Erb |
| RCA Astro-Electronic | Robert S. Lawton |
| RCA Astro-Govt. Systems Division | Dr. Ronald C. Maehl |
| RCA Astro-Electronic | Christopher White |
| Rockwell International | Thomas Cunnigham |
| Rocky Mountain Corp. for Public Broadcasting | E. Wayne Bundy |
| San Diego State University | John P. Witherspoon |
| Southern Baptist Conv/Radio & Television Corp. | Charles Roden |
| Southern Educational Comm. Assn. (SECA) | Virginia Fox |
| Spacecom | Dr. Louis J. Ippolito |

DISTRIBUTION - AEB 85-3

| | |
|---|---|
| Spacecom | Paul Flikkema |
| Satellite Business System | Donald Hill |
| Satellite Business System | Frank Stein |
| Satellite Business System | Dr. Duncan Mackinnon |
| Satellite Business System | Leonard Pugliese |
| Scientific Atlanta, Inc. | Ray Eckman |
| Scientific Atlanta, Inc. | Glenn Horning |
| Scientific Atlanta, Inc. | Boc Strickland |
| Scientific Atlanta, Inc. | B. L. Sullins |
| Southern Illinois University | Dr. K. S. Sitaram |
| Stanford University - Department EE | Dr. Roger Williamson |
| TRW, Inc. | Harold Braham |
| TRW, Inc | David Vidrine |
| U.S. Air Force Communications Command | Captain Donald Ryan, Jr. |
| U.S. Army - SATCOMA | James Bailey |
| U.S. Department of Commerce | Ray Jennings |
| U.S. Department of Commerce - NTIA | L. E. Gatterer |
| U S. Department of Commerce - NTIA | William A. Kissick |
| U.S. Dept. of Transportation | Dr. Carl C. Clark |
| U.S. Postal Service | Gordon C. Morrison |
| U.S. Secret Service | James J. Flyzik |
| U.S. Telephone and Telegraph Corporation | Stewart S. Flasher |
| University of Chicago | Bob Lowenstein |
| University of Miami | Dr. H. W. Hiser |
| Varian | Larry Hansen |
| Virginia Polytechnic Inst. & State University | W. L. Stutzman |
| Virginia Polytechnic Inst. & State University | R. C. Robertson |
| Virginia Polytechnic Inst. & State University | Dr. Charles Bostain |
| Vivid Systems | Grayson Gibbs |
| Voluntary Hospitals of America | J. Bruce Brennan |
| Western Michigan University | Charles Woodliff |
| Western Union Telegraph Company | Wallace P. Mack |
| Western Union Telegraph Company | John J. Spirito |

Enclosure 1

ACTS EXPERIMENTS MEETING

MARCH 26, 1985

HYATT REGENCY·CRYSTAL CITY, ARLINGTON, VA

AGENDA

| | TOPIC | SPEAKER | NO. OF VISUALS |
|---|---|---|---|
| - | Registration | | - |
| - | Welcome | Brandel | - |
| - | Introductory Remarks | Lovell | - |
| A | Program Goals | Brandel | 3 |
| B | ACTS Project | Gedney | 6 |
| C | Uses of ACTS Technoloogy | Schertler | 11 |
| - | Break | | |
| D | ACTS Communications System | Wright | 30 |
| - | Lunch | | |
| E | Ground Terminals | Knight | 24 |
| F | Experiments Program | Schertler | 15 |
| - | Break | | |
| G | Separate Group Discussions on Experiments | | |
| | 1. Technology (Flight, Ground, Network Control) | Wright | |
| | 2. Propagation (Impairments, Enhancement) | Manning | |
| | 3. System and Applications Experiments | Brandel | |
| H | Comments by the Associate Administrator for Space Science and Applications | Edelson | |
| I | Summary Remarks | Brandel | |
| - | Adjournment | | |

## ACTS EXPERIMENTS MEETING NO. 1

### ATTENDEES

| | |
|---|---|
| AT&T Bell Laboratories | Robert J. Brown |
| Alternative Systems Laboratory | Alfred Pietrzyk |
| American Medical Association | Carlos Martini, MD |
| American Satellite Company | Michael R. Helton |
| ANALEX | Patrick L. Donoughe |
| ANALEX | Michael Kerpchar |
| ANALEX | Robert Manning |
| Annenberg/CPB Project | Dr. Peter J. Dirr |
| Arizona State University | Lee C. Frischknecht |
| Bendix Field Engineering | William Pfeiffer |
| Boeing Aerospace Company | Dean Gahagan |
| Boeing Aerospace Company | David Wax |
| Booz-Allen & Hamilton | Marc A. Polster |
| COMSAT General Corporation | Carrie Devieux, Jr. |
| COMSAT Laboratories | Dr. S. J. Campanella |
| COMSAT Laboratories | Larry Palmer |
| Colorado Video, Inc. | David K. McIntosh |
| Consultant | Neil R. Helm |
| Department of Defense | Col. John Graves |
| Department of Defense | Major William Langford |
| Department of Defense | Richard Buehler |
| DocuNet | Jim Wilson |
| Fairchild Communications & Electronics | Don Marcopulos |
| Fairchild Communications & Electronics | Ed Habib |
| Fairchild Communications & Electronics | Daynay Chakraborty |
| Federal Communications Commission | Bruno Pattan |
| Federal Express | Richard Braley |
| Federal Express | Preston Vorlicek |
| Ford Aerospace | Carl Hellman |
| GTE - Government Systems | Hans J. Tiller |
| GTE - Spacenet | David F. Piske |
| GTE - Spacenet | Sid Skjei |
| GTE - Spacenet | Young Kim |
| GTE - Spacenet | Myong Kim |

ACTS EXPERIMENT MEETING NO. 1

ATTENDEES (Cont'd)

| | |
|---|---|
| GTE Laboratories, Inc. | E. P. Tweedy |
| GTE Sylvania | Henning Olesen |
| General Services Administration | Gregory Bain |
| General Services Administration | Robert Shephard |
| General Services Administration | Robert J. Hoffferty |
| | |
| Harris Corporation | Michael DeZego |
| IBM Federal Systems Division | Ralph J. Metz |
| Jet Propulsion Labs | Ernest K. Smith |
| John Hopkins University | Dr. Julius Goldhirsh |
| LNR Communications, Inc. | Julius Asmus |
| | |
| Library of Congress | Dr. Joseph Price |
| Library of Congress | Robert Carneal |
| M/A. - COM Research Center | Leonard S. Golding |
| M/A. - COM Telecom Div. | Jay Hustead |
| MIT - Lincoln Lab. | Mike Carter |
| | |
| MITRE Corporation | Joe Fernandez |
| MITRE Corporation | Richard Smith |
| Maryland Public Television | Sidney Tishler |
| Motorola Inc., Govt. Elec. Group | Ron Thomas |
| Motorola Inc., Govt. Elec. Group | Dave Carroll |
| | |
| N and F Associates (Creighton University) | Frederick H. Brigham, Jr |
| NBS/DOD Liaison | Brian C. Belanger |
| NASA Goddard Space Flight Center | S. H. Durrian |
| NASA Goddard Space Flight Center | Robert Fitzgerald |
| NASA Goddard Space Flight Center | Dr. Stanley Sobieski |
| | |
| NASA Headquarters | Dr. Burt Edelson |
| NASA Headquarters | Daniel L. Brandel |
| NASA Headquarters | Dominic Santarpia |
| NASA Headquarters | William T. Kondik |
| NASA Headquarters | Robert R. Lovell |
| | |
| NASA Lewis Research Center | Dr. Richard T. Gedney |
| NASA Lewis Research Center | John G. Bluck |
| NASA Lewis Research Center | William H. Hawersaat |
| NASA Lewis Research Center | Rodney M. Knight |
| NASA Lewis Research Center | Mary Ann Peto |

ACTS EXPERIMENTS MEETING NO. 1

ATTENDEES (Cont'd)

| | |
|---|---|
| NASA Lewis Research Center | Ronald J Schertler |
| NASA Lewis Research Center | David L. Wright |
| NASA Lewis Research Center | Bruce G. Lindow |
| NASA Lewis Research Center | Brian D. May |
| NASA Lewis Research Center | Dale E. Pope |
| National Communications System | Kenneth B. Boheim |
| National Communications System | Al Bartko |
| National Fire Protection Assn. | James Smalley |
| New York Institute of Technology | Sir John Manniello |
| ORI, Incorporated | Ronald Wallace |
| Public Service Satellite Consortium | Deb Gilman |
| Public Service Satellite Consortium | Karen Hutcheson |
| Public Service Satellite Consortium | Kim McDaniel |
| Public Service Satellite Consortium | Anderlene White |
| Public Service Satellite Consortium | Louis Bransford |
| Public Service Satellite Consortium | Mary D. Clark |
| Public Service Satellite Consortium | H. Rex Lee |
| Public Service Satellite Consortium | Suzanne Douglas |
| RCA | Dave Wilkinson |
| RCA - American | Sandra Erb |
| RCA - Astro Electronic | Christopher White |
| Spacecom | Dr. Louis J. Ippolito |
| Spacecom | Paul Flikkema |
| Satellite Business System | Donald Hill |
| Satellite Business System | Frank Stein |
| Satellite Business System | Dr. Duncan Mackinnon |
| Satellite Business System | Leonard Pugliese |
| Scientific Atlanta, Inc. | Ray Eckman |
| Scientific Atlanta, Inc. | Glenn Horning |
| Scientific Atlanta, Inc. | Boc Strickland |
| Scientific Atlanta, Inc. | B. L. Sullins |
| Southern Illinois University | Dr. K. S. Sitaram |
| TRW, Inc. | Harold Braham |
| TRW, Inc. | David Vidrine |
| U.S. Dept. of Transportation | Dr. Carl C. Clark |
| U.S. Department of Commerce - NTIA | William A. Kissick |

ACTS EXPERIMENTS MEETING NO. 1

ATTENDEES (Cont'd)

| | |
|---|---|
| University of Chicago | Bob Lowenstein |
| University of Miami | Dr. H. W. Hiser |
| Virginia Polytechnic Inst. & State University | W. L. Stutzman |
| Virginia Polytechnic Inst. & State University | R. C. Robertson |
| Virginia Polytechnic Inst. & State University | Dr. Charles Bostain |
| Voluntary Hospitals of America | J. Bruce Brennan |
| Western Michigan University | Charles Woodliff |
| Western Union Telegraph Company | Wallace P. Mack |
| Western Union Telegraph Company | Jobn J. Spirito |

TOTAL - 114

## ACTS EXPERIMENTS MEETING - SEPARATE GROUP DISCUSSIONS

### Group G-1 - Technology -- Attendees

| Organization | Attendee | State | Phone Number |
|---|---|---|---|
| NASA Lewis | Dave Wright (Chairman) | OH | (216) 433-4000 x6618 |
| ANALEX Corp. | Pat Donoughe | OH | (216) 433-4000 x6497 |
| American Satellite Co. | Mike Helton | MD | (301) 251-4476 |
| Comsat Labs | Larry Palmer | MD | (301) 428-4575 |
| DOD | Richard Buehler | MD | (301) 688-8281 |
| FCC/OST | B. Pattan | DC | (202) 632-7073 |
| GTE Spacenet | Myong C. Kim | VA | (703) 790-7892 |
| Harris Corp. GSCD | M. DeZego | FL | (305) 729-2950 |
| IBM-FSD | Ralph Metz | MD | (301) 258-7255 |
| MACOM Research Ctr. | Leonard S. Golding | MD | (301) 258-8163 |
| Motorola | Ron Thomas | AZ | (602) 949-3814 |
| NASA Hqs. | D. Santarpia | DC | (202) 453-1505 |
| NASA LeRC | Bruce Lindow | OH | (216) 433-4000 x792 |
| Nat'l Bur. of Standards | Brian Belanger | MD | (301) 921-2805 |
| PSSC | Lou Bransford | DC | (202) 331-1154 |
| Satellite Business Sys. | Don Hill | VA | (703) 749-7128 |
| SPACECOM | Paul Flikkema | MD | (301) 258-6892 |
| Virginia Tech. | Warren Stutzman | VA | (703) 961-6834 |

### Group G-Z - Propagation -- Attendees

| Organization | Attendee | State | Phone Number |
|---|---|---|---|
| ANALEX Corp. | Robert M. Manning (Chairman) | OH | (216) 433-4000 x5319 |
| ANALEX Corp. | Mike Kerpchar | NJ | (201) 335-0933 |
| Boeing | David W. Wax | WA | (206) 773-0768 |
| GTE | Hans J. Tiller | MA | (617) 466-5144 |
| GTE Laboratories, Inc. | E. Paterson Tweedy | MA | (617) 466-2661 |
| Nat'l Bureau of Standards | Brian Belanger | MD | (301) 497-3557 |
| ORI, Inc. | Ronald Wallace | MD | (301) 670-2278 |
| SPACECOM | Louis J. Ippolito | MD | (301) 258-6933 |
| University of Miami | Dr. H. W. Hiser | FL | (305) 284-3881 |
| Virginia Tech. | Charles W. Bostian | VA | (703) 961-6834 |

## ACTS EXPERIMENTS MEETING - SEPARATE GROUP DISCUSSIONS

### Group G-3 - System & Applications -- Attendees

| Organization | Attendee | State | Phone Number |
|---|---|---|---|
| NASA Hqs. | Dan Brandel (Chairman) | DC | (202) 453-1505 |
| ANALEX Corp. | Pat Donoughe | OH | (216) 433-4000 |
| AT&T Bell Labs. | R. J. Brown | NJ | (201) 949-4394 |
| Alternative Sys. Lab. | Alfred Pietrzyk | MD | (301) 730-2748 |
| Annenberg/CPB Project | Peter J. Dirr | DC | (202) 955-5255 |
| Arizona State Univ. | Lee C. Frischknecht | AZ | (602) 965-2314 |
| Boeing Aerospace | Dean Gahagan | WA | (206) 773-1093 |
| Booz-Allen & Hamilton | Marc Polster | MD | (301) 951-2457 |
| COMSAT General | C. Devieux | DC | (202) 863-7416 |
| COMSAT Labs. | S. J. Campanella | MD | (301) 428-4258 |
| Consultant | Neil Helm | DC | (202) 363-1169 |
| Creighton - Bethesda | Frederick Brigham | MD | (202) 635-5453 |
| Creighton - Omaha | Frederick Brigham | NB | (402) 280-3165 |
| DEF COMM Agency | Bill Langford | VA | (703) 883-5513 |
| Fairchild Industries | D. Chakraborty | MD | (301) 428-6564 |
| GTE Spacenet | Young K. Kim | VA | (703) 790-7837 |
| GTE Spacenet | D. Piske | VA | (703) 790-7870 |
| Gen. Svcs. Admin. | Gregory Bain | DC | (202) 566-0174 |
| Gen. Svcs. Admin. | Bob Hofferty | DC | (202) 566-1002 |
| LNR Communications, Inc. | Julius R. Asmus | NY | (516) 273-7111 |
| M/A Com Telecom | Jay Husted | MD | (301) 428-5575 |
| MIT - Lincoln Laboratory | Dr. Michael J. Carter | MA | (617) 863-5500 x4191 |
| MITRE Corp. | Joe Fernandez | VA | (703) 883-7052 |
| Maryland Public TV | Sidney Tishler | MD | (301) 337-4145 |
| Motorola | David Carroll | AZ | (602) 949-2456 |
| NASA GSFC | Robert Fitzgerald | MD | (301) 344-7653 |
| NASA GSFC | Stanley Sobieski | MD | (301) 344-5148 |
| NASA Hqs. | Bill Kondik | DC | (202) 453-1505 |
| NASA LeRC | John Bluck | OH | (216) 433-4000 x498 |
| NASA LeRC | Rod Knight | OH | (216) 433-4000 x5519 |
| NASA LeRC | Dale E. Pope | OH | (216) 433-4000 x5378 |
| NASA LeRC | Richard Gedney | OH | (216) 433-4000 x6209 |
| NASA LeRC | Ronald Schertler | OH | (216) 433-4000 x6792 |
| National Comm. System | Alexander C. Bartko | DC | (202) 692-2813 |
| NTIA/ITS | W. A. Kissick | CO | (303) 497-3723 |

ACTS EXPERIMENTS MEETING - SEPARATE GROUP DISCUSSIONS

Group G-3 - System & Applications -- Attendees (Cont'd)

| Organization | Attendee | State | Phone Number |
|---|---|---|---|
| Nat'l Fire Prot. Assn. | James C. Smalley | MA | (617) 770-3000 |
| PSSC | Deborah Gilman | DC | (202) 331-1154 |
| PSSC | Suzanne Douglas | DC | (202) 331-1154 |
| RCA American Comm., Inc. | Sandra Erb | NJ | (609) 734-4077 |
| RCA Astro | Chris White | NJ | (609) 426-3077 |
| SBS | Duncan Mackinnon | VA | (703) 442-6006 |
| SPACECOM | Louis J. Ippolito | MD | (301) 258-6933 |
| Satellite Bus. Sys. | L. Pugliese | VA | (703) 442-6039 |
| TRW | Harold Braham | CA | (213) 535-3196 |
| TRW | David M. Vidrine | CA | (213) 297-2363 |
| U. S. Dept. of Trans. | Carl C. Clark | DC | (202) 426-1875 |
| U. of Chicago/Yerves Observ | Bob Loewenstein | WI | (414) 245-5555 |
| Virginia Tech/EE Dept. | R. Clark Robertson | VA | (703) 961-6622 |
| Western Union Telegraph Co. | Wallace P. Mack | VA | (703) 790-2229 |

NASA
Lewis Research Center

## NASA'S EXPERIMENT TERMINAL PROGRAM FOR ACTS

ACTS ADVANCED COMMUNICATIONS TECHNOLOGY SATELLITE

Enclosure 4
(Final Visual - Topic E)

NASA WILL

- WORK WITH EXPERIMENTERS TO IDENTIFY REQUIREMENTS AND DEVELOP SPECIFICATIONS FOR A FAMILY OF ACTS TERMINALS
- IDENTIFY COST DRIVERS AND DEVELOP ALTERNATIVE LOW-COST TECHNOLOGY
- ENCOURAGE GROUND TERMINAL MANUFACTURERS TO DEVELOP "LINE" OF ACTS COMPATIBLE TERMINALS FOR EXPERIMENTERS
- LEASE OR BUY GROUND TERMINALS FOR GOVERNMENT EXPERIMENTS
- OFFER EXPERIMENTERS THE OPPORTUNITY TO JOIN WITH THE GOVERNMENT IN A GROUP LEASING OR BUYING OF GROUND TERMINALS
- AGGREGATE EXPERIMENTERS TO SHARE TERMINALS

AEB 85-4
April 18, 1985

# ACTS EXPERIMENTS QUESTIONNAIRE

Name: ____________________

Title: ____________________

Organization: ____________________

Address: ____________________
____________________

Phone: ____________________

1. What is the title (if known) of your possible experiment?

____________________

2a. How would you categorize your potential experiment or experimental interest?

_______ End to end system verification
_______ Flight system technology
_______ Ground system technology
_______ Network control
_______ Acquisition, tracking and sychronization
_______ Enhancement of link availability/rain compensation techniques
_______ Propagation
_______ Applications

2b. If you checked applications, please specify your area(s) of interest (for example, high definition television, customer premise services).

____________________
____________________

3a. Do you need a copy of the Notice of Intent (NOI), which provides guidelines for submitting a letter or response?

______yes ______no

3b. Do you need additional information or technical assistance in order to determine the ultimate operational value of being an ACTS experimenter?

______yes ______no

3c. Do you need additional information or technical assistance in the planning of your potential experiment?

______yes ______no

4a. Can you provide rough estimates of your potential experimental requirements on ACTS?

- 0 Will you need the High Burst Rate Mode? ___yes ___no ___not sure
- 0 Will you need the Low Burst Rate Mode? ___yes ___no ___not sure
- 0 Will you need the FDMA Mode? ___yes ___no ___not sure

4b. Do you know the duration of satellite time needed?

___yes ___no ___not sure If "yes" please comment______________________________

____________________________________________________________

5. Please indicate your willingness to share ground station equipment and facilities: (Please check the most appropriate answer)

_______ I am willing to share my equipment with other experimenters
_______ I desire to share equipment owned or managed by others (NASA or other experimenters)
_______ I desire joint ownership and usage with others
_______ I am unable to share equipment (e.g. proprietary experiments)

6. Please indicate (if known) the locations for ground stations in your potential experiment:

____________________________________________________________

____________________________________________________________

7. Would your potential experiment benefit from the use of a:

- 0 Transportable earth station? ___yes ___no ___not sure
- 0 Mobile earth station? ___yes ___no ___not sure

8. Please indicate your preference for experimenters meeting locations:

_______ East (Washington, DC)
_______ Mid-west (Cleveland, OH)
_______ West ________________________________suggestion
_______ South ________________________________suggestion
_______ Other ________________________________suggestion

9. How would you describe your organization's position on the ACTS Program?

______ Planning to become an experimenter
______ Seriously considering becoming an experimenter
______ Unable to determine position at this time, but still interested
______ Highly unlikely organization will participate in the ACTS Program
______ Other:__________________________________________

10. Is there anyone else in your organization that should be contacted regarding the ACTS Program?

_______________________________________________________________

11. Other Comments:(Please use this page to write comments)

____Check here if you wish to remain on the ACTS Mailing List.

Thank you for your prompt response and interest in ACTS. Please return the questionnaire to:

Ron Schertler
ACTS Project Experiments Manager
NASA Lewis Research Center
Mail Code 54-6
21000 Brookpark Road
Cleveland, Ohio 44135

National Aeronautics and
Space Administration

**Lewis Research Center**
Cleveland, Ohio
44135

NASA

Reply to Attn of:

ADVANCED COMMUNICATIONS TECHNOLOGY SATELLITE

(ACTS)

EXPERIMENTS PROGRAM

Enclosed is a copy of the NASA Advanced Communications Technology Satellite (ACTS) Notice of Intent for Experimenters released by the Office of Space Science and Applications for your review and consideration.

NASA has initiated the flight experimentation phase of its Advanced Communications Technology Satellite Program by signing a contract with an industry team headed by RCA's Astro-Electronics Group in Princton, New Jersey to develop ACTS for launch from the space shuttle in 1989.

NASA Headquarters has designated Dr. Daniel Brandel as ACTS Program Manager and Lt. Col. William Kondik as the Deputy ACTS Program Manager. The NASA Lewis Research Center has been assigned responsibility for the ACTS Project and has designated Dr. Richard Gedney as Acting ACTS Project Manager, Mr. William Hawersaat as ACTS Deputy Project Manager, and Mr. Ronald Schertler as ACTS Project Experiments Manager.

The ACTS contract industry team consists of RCA Astro-Electronics, who will be the prime contractor and who will be responsible for the spacecraft bus and for integration and test of the system; TRW, who will be responsible for design and development of the Multibeam Communications Package; and, COMSAT, who will be responsible for the design and development of the NASA Ground Station and Master Control Station and for operations and maintenance during the two-year experiment period. Other major participants of the industry team are MOTOROLA, who will provide the baseband processor, Hughes, who will provide the 20 GHz traveling wave tube; and Electromagnetic Sciences, who will provide the beam forming network for the multibeam antenna.

This Notice of Intent (NOI) solicits an expression of interest from those organizations interested in potential experimentation with the ACTS System. An expression of interest to participate in the program does not require a commitment at this time. That commitment would be required later in response to the NASA ACTS Experiment Opportunity Notice, presently scheduled for release in 1986.

The NOI reviews the background and objectives of the ACTS experiments program, outlines the ACTS system technical details, and provides information about submitting a NOI.

It is the intent of NASA to consider all experiments that are technically and scientifically relevant to the basic objectives of the ACTS Program and for which the ACTS System can accommodate. After the NOI responses are received, each will be reviewed for compatibility with ACTS; and all those in that category will be so indicated.

NASA recognizes that it may be of interest to some organizations experimenting with ACTS to keep certain information regarding the conduct of their experiment or its analyzed results proprietary. Public disclosure of an ACTS experiment and its analyzed results is certainly encouraged. Legal, cooperative agreements protecting proprietary information, however, can be entered between NASA and those organizations so desiring, on an individual basis. Such an agreement will protect the proprietary aspects of an experiment from public dissemination while still providing NASA with an evaluation and verification of the performance of the ACTS spacecraft.

It will be necessary to finalize the locations of both the fixed and scanning ACTS beams by mid-1985. Since ACTS will provide only limited CONUS coverage, it is important to identify the location of ground terminals for your experiment.

NASA will continue to solicit and accept NOI's at any time. If you have any questions regarding the ACTS Experiments Program or require additional information, please contact Ronald Schertler at (216) 433-4000, ext. 792.

The ACTS Program affords an exciting challenge to all and provides a unique opportunity to be in the forefront of satellite communications technology. NASA hopes that you are able to participate in the ACTS Experiments Program.

The NOI recites the background and objectives of the ACTS experiments program, outlines the ACTS system technical details, and provides information about submitting a NOI.

It is the intent of NASA to consider all experiments that are technically and scientifically relevant to the basic objectives of the ACTS program and for which the ACTS system can be [illegible]. If [illegible] are received, each will be reviewed for compatibility with ACTS, [illegible] in that category will be [illegible].

NASA recognizes that it may be of interest to some organizations experimenting with ACTS to keep certain information regarding the conduct of their experiment or its results [illegible]. Public disclosure of an ACTS experiment and its analyzed results is [illegible]. [illegible] cooperative agreement [illegible] entered between NASA and each [illegible] on an individual basis. Each [illegible] will [illegible] experiment [illegible] of an experiment [illegible] NASA with an evaluation [illegible] of the [illegible] of the [illegible].

It will be necessary to [illegible] both the [illegible] and [illegible] ACTS [illegible] will [illegible] ACTS experiments. It is important to identify the [illegible] for your experiment.

NASA will continue to [illegible] NOI's at any time. If you have any questions regarding the ACTS Experiments Program or need [illegible] information, please contact [illegible] at [illegible].

The ACTS program [illegible] and provides a unique opportunity [illegible] communications technology. NASA hopes that you will [illegible] ACTS experiments program.